SCIENCE

JANUARY 27, 1950

A NATIONAL SCIENCE FOUNDATION: 1950 PROSPECTS

DAEL WOLFLE

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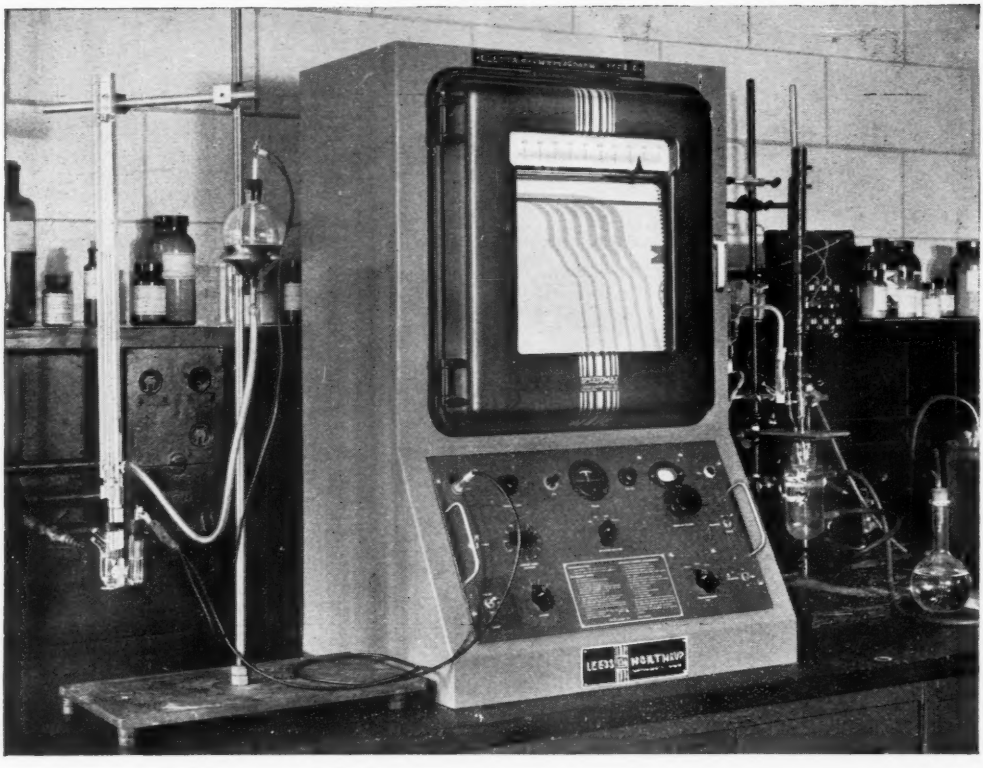

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What GENERAL ELECTRIC People are Saying

E. E. CHARLTON

Research Laboratory

MEDICAL ELECTRONICS: In medical x-ray diagnosis we have, in the last few years, seen the use of the fluoroscope decrease in comparison with the radiography. Why has this been? The reason is twofold. The patient and the doctor were both subjected to so much radiation that the hazards of radiation damage imposed severe limitations on adequate and flexible fluoroscopic techniques. Furthermore, these hazards imposed the use of low x-ray intensities yielding screen images of such low luminosity that the limitations of the human eye precluded high resolution; that is, the recognition of fine detail. The enforced requirement of low x-ray intensity also brings with it the necessity of a 15- or 20-minute period for dark adaptation of the eyes in preparation for the fluoroscopic examination. The doctor must also limit his examination to brief glimpses rather than a more detailed study of the screen image. If the required x-ray intensities for examination could be reduced and the fluoroscopic picture sufficiently increased in brilliance, these limitations would be largely dissipated.

It seems certain that electronics will come to the rescue in this problem by removing many and perhaps all of these limitations. Of various systems that have been proposed and are being investigated, one that holds great promise makes use of some form of electron image tube and embodies some of the principles of the wartime sniperscope, by which our soldiers were enabled to see the enemy in the dark . . . Such an x-ray image tube intensifier offers the possibility of an amplification of as much as several hundred fold in brightness while at the same time increasing resolution. Successful attainment of this goal will not only greatly enhance the usefulness of the fluoroscopic method but will also facilitate photographic recording of the image, especially in those cases where moving pictures are desired. A full realization of all that the method promises would be quite revolutionary in the x-ray art.

6th Inter-American Congress of Surgery, Chicago, October 21, 1949

A. H. TAYLOR

Lighting Research Laboratory

MOLD CONTROL: Every housewife has experienced the loss of foodstuffs by reason of molds. Likewise, manufacturers of many products incur losses produced by mold contamination at some point in the manufacturing process. In total these losses amount to millions of dollars yearly; consequently, any practical method of reducing losses due to molds should be of great general interest.

Air-borne mold spores, originating in decaying animal and vegetable matter, are more widely distributed in outdoor and indoor air than is generally recognized . . .

It has long been known that bacteria could be killed by suitable exposures to ultraviolet, but little was known regarding its effect upon air-borne mold spores. The introduction of germicidal lamps . . . made it feasible to apply them to the disinfection of air, some liquids, and the surfaces of solids. Researches . . . have shown that the mold spores can also be inactivated by the germicidal ultraviolet energy, but that the required dosages are much higher than for most bacteria . . .

Although mold spores are much more resistant to germicidal ultraviolet than are the mixed organisms in saliva, . . . it should be possible to reduce economic losses due to mold contamination—especially during manufacturing processes—by practicable installations of germicidal lamps. Furthermore, they can be applied to upper-air irradiation of occupied rooms without exceeding intensities safe for the occupants of the rooms. Thus personnel and product protection can be promoted simultaneously with the same installation of germicidal lamps. Applications of localized high-intensity radiation over production lines, such as bottling or canning, are being used with good results in many places. While it is unreasonable to expect the germicidal lamps to completely eliminate economic losses due to molds, such losses can be materially reduced.

American Public Health Assn., New York City, October 28, 1949

A National Science Foundation: 1950 Prospects

Dael Wolfle
American Psychological Association, Washington, D. C.

SCIENTISTS HAVE AN IMMEDIATE OPPORTUNITY to help secure enactment of the National Science Foundation Act that Congress has been considering, in one form or another, for the last five years. Most of the differences over specific features have been compromised, and there is reasonable basis for the optimistic hope that 1950 can see the long campaign successfully ended with the actual establishment of a National Science Foundation. The achievement of that possibility rests partly upon the many scientists and other individuals who believe the Foundation should be created. They can help secure passage by letting members of the House of Representatives know, immediately and in volume, what they think of the bill now before the House.

The Senate has four times passed a Science Foundation bill, the House of Representatives once. The President has repeatedly urged Congress to create a National Science Foundation and did so most recently in his State of the Union and budget messages to Congress for 1950. Cabinet members, the Bureau of the Budget, the Office of Naval Research, and the Research and Development Board have all recommended it. So have individual scientists, associations of scientists, and the National Association of Manufacturers. Nearly everyone is in favor of establishing the Foundation, but so far not enough have agreed at the same time on the same bill to get a Foundation established in law.

In 1946 the Senate passed S. 1850 after long, detailed, and careful hearings. When that bill was sent to the House of Representatives it was allowed to die in committee, partly because the House members did not have time to study it adequately, partly because scientists themselves were sharply divided on the kind of Foundation they thought would best serve the country.

In 1947, when the Republicans took control of Congress, the Senate passed a Science Foundation bill which differed in a number of respects from the one they had passed the year before. It was passed later by the House of Representatives, but vetoed by President Truman because of his objections to some of its administrative features.

In 1948 the bill which had passed both houses of Congress the year before was modified to meet the President's objections. Again it passed the Senate. But it died when the Rules Committee failed to give it a place on the House calendar.

In 1949, with the Democrats back in control of Congress, the same bill that the Senate had approved in 1948 was reintroduced and again passed. An essentially similar bill was introduced in the House, approved by the Committee on Interstate and Foreign Commerce, and again prevented by the Rules Committee from coming to vote.

Now it is 1950. The 81st Congress has returned for its second session and can again take up the National Science Foundation Act. On the Senate side nothing needs to be done immediately. S. 247, which passed the Senate on March 18, 1949, is still alive, waiting for similar action in the House and then signature by the President. In the House, H. R. 4846 has been approved by the Committee on Interstate and Foreign Commerce, recommended to the House as a whole, and is ready to be voted upon whenever the House takes it up. As this is written, the bill is still held up in the Rules Committee, but there are good indications that it need not be held there long. There are two possibilities for getting H. R. 4846 out of the Rules Committee and onto the floor of the House for vote. One, the normal channel, is for the Rules Committee to place it on the House calendar. Last year the Rules Committee refused to do that. Representative James Wadsworth of New York is generally credited with leadership in opposing release of the bill by the Rules Committee. His reason, he stated, was that "he was hesitant and others on the committee felt hesitant about taking on new financial commitments which the Foundation would require" (Washington City News Service press release of August 18, 1949). Since the October adjournment of Congress, however, it is reported that Representative Wadsworth has agreed to withdraw his opposition so that the bill can be voted upon by the House of Representatives.

If that fails, if the Rules Committee does not place the bill on the House calendar, there is another method of securing an opportunity for the House to vote on it. Representative Robert Crosser, chairman of the Committee on Interstate and Foreign Commerce, last year requested the House to take up the bill regardless of the Rules Committee's failure to release it. A request of this kind can be acted upon only on the second and

fourth Mondays of a month; and the House itself must agree that it is willing to consider the bill, even though the Rules Committee has not released it. Mr. Crosser was in Europe on the days last fall when the bill could be called up for vote under this procedure, and no one could substitute for him in this role. If the Rules Committee does not release the bill, this alternative method of getting it up for vote can be used.

When H. R. 4846 is voted upon by the House it will not be identical with the bill which the Senate has already approved. The two are similar in most respects, both to each other and to the bills that were considered in 1948, but there are several distinctions between the House and Senate versions.

H. R. 4846 is a better-written bill in its details than S. 247. The various sections are more logically arranged, and the wording is more precise in a number of spots. For example, where the Senate bill speaks only of the "Foundation," the House Bill states that "The Foundation shall consist of a National Science Board (hereinafter referred to as the Board) and a Director." In a number of later sections H. R. 4846 differentiates more clearly than does the Senate bill between the responsibilities of the board and those of the director. Or, for a more amusing example, the Senate version states that arrangements with individuals or agencies in other countries "shall be exercised in such manner as is consistent with the foreign policy objectives of the United States as determined by the Secretary of State after consultation with the Director." The House version is reworded to remove the implication that the Secretary of State must confer with the director of the National Science Foundation in order to determine our foreign policy objectives.

In terms of organization of the Foundation itself, the major difference between the two bills is that the House version requires the board to select an executive committee which will be responsible for a number of details of policy formation and administrative supervision. The Senate version leaves the creation of an executive committee optional with the board itself. It is generally desirable to impose as little unnecessary restriction as possible on an agency whose problems and needs may change from time to time. So in this respect the Senate version is considered preferable by many people. Nevertheless, it is most unlikely that the Foundation would try to act without an executive committee. In practice, therefore, both bills would probably work out the same way, and so either should be acceptable to most scientists.

Three amendments to H. R. 4846 which have been recommended by the House Committee on Interstate and Foreign Commerce are of considerable importance. Section 3 (a) (6) of the House bill and Section 4 (a) (6) of the Senate bill give as one of the functions of the Foundation:

> . . . to correlate the Foundation's scientific research programs with those undertaken by individuals and by public and private research groups.

The proposed amendment to H. R. 4846 would change this section to read:

> . . . to evaluate scientific research programs undertaken by individuals and by public and private research groups, including scientific research programs of agencies of the Federal Government, and to correlate the Foundation's scientific research programs with such programs.

Of related interest is the proposed amendment to delete from H. R. 4846 the following statement, which now appears in both House and Senate bills:

> The activities of the Foundation shall be construed as supplementing and not as superseding, curtailing, or limiting any of the functions or activities of other Government agencies authorized to engage in scientific research or development.

Taken together, these two proposed amendments would give the Foundation called for by the House bill a somewhat greater coordinating power than that granted to the Foundation by the Senate bill.

The proposed Foundation would have three major functions. It would grant funds to subsidize approved research projects. It would offer fellowships and scholarships to students of the sciences. And it would serve as a top-level planning and coordinating agency for the nation's scientific program. There is no thought that it would put existing agencies, such as the Office of Naval Research or the research activities of the Department of Agriculture, out of business. Nevertheless, the House and Senate bills would give the Foundation a different status on its coordinating function. The Senate bill would require it to coordinate its own program with other existing ones and would instruct it not to step on any other agency's toes. The House bill would instruct it to keep an eye on other research programs, both government and private, and would remove the prohibition against stepping on another federal agency's toes if it finds something undesirable in that agency's program. The Senate version is therefore likely to be preferred by other federal agencies. Yet the House version would mean a stronger Foundation. The relative merits of these two views have not been given much consideration by scientists. The stronger version of the House bill seems to me to be preferable. The government's scientific activities are both great enough in scope and diverse enough in sponsorship to justify a Foundation with more authority than the purely negative one of seeing that its program is correlated with those undertaken by other individuals and groups.

The third proposed amendment would add a loyalty oath requirement for scholarship and fellowship holders. The amendment would add a part (b) to Section 10 reading as follows:

No part of any funds appropriated or otherwise made available for expenditure by the Foundation under authority of this Act shall be used to make payments under any scholarship or fellowship to any individual unless there is on file with the Foundation an affidavit executed by such individual that he does not believe in, and is not a member of and does not support any organization that believes in or teaches, the overthrow of the United States Government by force or violence or by any illegal or unconstitutional methods. The provisions of section 1001 of title 18, United States Code, shall be applicable in respect of such affidavits.

This amendment was proposed to the very great regret of scientists and to the equal regret of a number of members of Congress. It was proposed last spring when Atomic Energy Commission fellowship holders were under fire from other Congressional committees. It is a concession to the current temper of Congress and many citizens. But it is unnecessary; overt treason or acts of disloyalty are adequately handled by existing law, which is not strengthened by the affidavit requirement. It is also an invasion of freedom, and it is disturbing to have undergraduate and graduate students majoring in any of the sciences and supported by Foundation funds required to sign such an affidavit regardless of whether the work upon which they are engaged requires security classification or not. The affidavit is, however, a milder requirement than the FBI investigation which must now be made of all Atomic Energy Commission Fellows, and accepting it may be necessary. At its meeting in New York City on December 27 the Inter-Society Committee for a National Science Foundation formally voted its disapproval of the inclusion of this proposed amendment. At the same time, if the amendment is added despite the opposition which it will arouse, the bill as a whole will have the support of the Inter-Society Committee.

If all goes well, the House should have an opportunity to vote on H. R. 4846 before the end of February. The chances are fairly good that the House will approve the bill. There will be some opposition on grounds of economy. The patent interests will oppose it. There may be a whispering campaign about un-American activities of some scientists. But if enough Representatives know that the scientists and educators of their own regions are solidly in favor of the bill, it will pass despite the opposition. A conference will then be necessary to resolve the differences between the House and Senate versions. Unless the House bill is changed much more drastically than now seems likely, it should not be difficult to resolve the differences, nor should there be any question about subsequent passage of the compromise measure by both houses of Congress and its approval by President Truman.

The immediate job is to get the bill out of the Rules Committee so that the House can vote on it. That is primarily a job for the legislative strategists. Then will come the question of votes by the House, first on proposed amendments, and then on the bill as a whole. Because the House has not considered National Science Foundation legislation as frequently or in as much detail as has the Senate, many Representatives are not well informed on the necessity for the Foundation or on the characteristics that would make it work most effectively. Neither are many of them aware of the importance attached to this legislation by scientists and educators in their own districts. Each individual scientist can help remedy that situation by talking or writing to the Representatives from his own district. Each Representative should know the attitudes of the scientists in his home district. Giving members of the House assurance that H. R. 4846 will make important contributions to the nation's welfare is therefore the responsibility of all scientists, all over the country.

Principles of Emulsion Polymerization[1]

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SYNTHETIC POLYMERS, especially those that exhibit rubberlike characteristics and those that can be drawn into fibers, have attracted increasing interest in recent years. Both the technology and the basic knowledge of polymer processes have advanced. This article will be concerned with the fundamental principles of a particular kind of polymerization—namely, vinyl polymerization in emulsion. Even with this limitation, the subject is so vast that only a cursory treatment is possible here. Accordingly, the discussion will be further restricted to those aspects of the subject relating to the author's own work or the work of his associates.

A complete understanding of emulsion polymerization would require a knowledge of a great many branches of chemistry. Obviously, one must recognize the organic chemistry involved to describe how the molecules start growing, how the reaction is sustained, and how the molecular growth finally stops. The kinetics of polymerization processes are also important, both from the point of view of attaining practical speeds and because of their influence on the structure of the product. Finally, in emulsion systems, the phase relationships are of paramount significance by reason of their marked influence on the kinetics and the corresponding control of the possible reactions. We shall now endeavor to discuss each of these topics in turn, with particular emphasis on the kinetics and phase relationships.

The Polymerization Reaction

Vinyl type polymerizations, whether they occur in single or multiple phase systems, are characterized by a free radical type of chain growth. To initiate the reaction it is necessary to generate free radicals, either by ordinary chemical decomposition of appropriate catalysts or by photochemical processes. Certain organic peroxides are commonly employed as catalysts, since they can yield free radicals by thermal decomposition (*6*) or by reduction activation (*4, 12*). Denoting the initiating radicals by R · and the monomers by M, we can write the polymerization reaction as

$$\begin{aligned} &R\cdot + M \rightarrow RM\cdot \\ &RM\cdot + M \rightarrow RM_2\cdot \\ &RM_n\cdot + M \rightarrow RM_{n+1}\cdot \\ &\text{etc.} \end{aligned}$$

The chain growth process will not continue indefinitely, however, because certain other reactions can also occur which result in chain termination. In practice, the chain lengths are often controlled by the introduction of chain transfer agents or modifiers (*1, 7, 10*) which operate according to the reaction

$$RM_n\cdot + YZ \rightarrow RM_nY + Z\cdot$$

followed by

$$Z\cdot + M \rightarrow ZM\cdot \text{ etc.}$$

Carbon tetrachloride and certain mercaptans can be effectively used as modifiers for some polymerization reactions. Organic peroxides, in addition to serving as catalysts, can also act as modifiers, especially in the redox system to be discussed later (*13*).

The modification reaction is characterized by the fact that the growing chain abstracts an atom or group from a nonradical molecule, thereby transferring the free radical characteristic elsewhere (*1*). The new free radical can then undergo growth by addition of further monomer units and the cycle repeated. It must not be supposed that the modification reaction occurs at any critical degree of polymerization; instead it is a very random type of reaction, governed largely by probability. This results in marked heterogeneity of molecular weights in the final product.

If no modifier is added to a polymerization system, the molecular weights will tend to be high, but some sort of chain termination must always occur. If necessary, a growing free radical will remove an atom (hydrogen, for example) from a polymer molecule already formed (*9, 11*). This renders the polymer molecule a free radical again, enabling it to grow once more. From probability considerations it is clear that the atom removed from the polymer molecule is unlikely to be at the end of the molecule; accordingly, the secondary growth process will result in the formation of a branch attached to the original molecule. At high conversions the degree of branching can be considerable, and the polymer molecules will tend to look more like trees than like ordinary chains.

At this stage it is well to discuss another phenomenon frequently encountered in polymerization, namely, cross-linking. For reasons to be discussed presently, cross-linking should be considered different from branching, even though superficially they appear to have similar characteristics. Cross-linking occurs during polymerization, when a growing polymeric free

[1] Based on a paper presented at the 23d National Colloid Symposium, held in Minneapolis, Minnesota, June 6–8, 1949.

radical chain adds on a polymer molecule instead of a monomer, the addition involving some residual unsaturation in the polymer (*9, 11*). Butadiene polymers can obviously undergo cross-linking, since only one double bond is lost for each monomer unit in the primary chain growth process. Since the polymer itself has a great deal of unsaturation, it is not at all improbable that at high conversions the free radicals will react with polymer instead of with monomer. Although branching tends to build up treelike structures, cross-linking goes further than this, for it ultimately gives rise to networks. When cross-linking occurs there is either a decrease in the number of molecules or a building up of network structures. When the network is big enough, the resulting polymer system becomes an insoluble gel, which can, however, be swollen by appropriate liquids, especially those that would be solvents for the non-cross-linked material. Direct evidence for cross-linking has been obtained by studies of molecular weights as functions of conversion (*11*). Such investigations have shown that in some of the advanced stages of the reaction there is an actual decrease in the number of polymer molecules with increasing conversion.

Kinetics of Polymerization Reaction

An ordinary vinyl type polymerization taking place in dilute solution might be expected to be first order with respect to monomer concentration. The specific reaction rate constants will, of course, depend upon the catalyst used and upon the nature of the processes involved in generating and removing free radicals. For emulsions, on the other hand, the kinetics are considerably more complicated. It is found empirically that for a great many emulsion polymerizations the reaction appears to be zeroth order up to as high as 60 percent conversion, after which the rate falls off rapidly. The copolymerization of butadiene and styrene to make GR-S synthetic rubber follows such a pattern (*12*). It must not be inferred, however, that all emulsion polymerizations are zeroth order, for some systems do exhibit marked departures. The zeroth order behavior which is frequently observed suggests that the concentration of monomer in the reaction locus remains substantially constant.

Low Temperature Redox Polymerization

Vinyl type polymer growth reactions frequently involve several reaction possibilities, with the result that the polymer does not have a uniform structure. Diene polymers in particular exhibit such structural variations, since a monomer unit might appear in the polymer in *cis* or *trans* forms, if the addition was 1–4, or it might appear to have added in 1–2 or 3–4 fashions, the latter two being distinguishable only if the diene is unsymmetrical. Besides the aforementioned branching and cross-linking, still other "side reactions" are possible. At high temperatures there is a tendency for randomness in accordance with the general effect of increased temperature on relative reaction probabilities. At low temperatures, on the other hand, certain specific reactions may be favored, with the result that the polymer structure will be more nearly uniform. If this uniformity should manifest itself in more desirable polymer properties, and this is often the case, then a low temperature polymerization would appear to be in order. The so-called "cold rubber," which is prepared at low temperatures by a redox system, is in fact superior to ordinary GR-S.

Unfortunately, the catalyst systems developed for higher temperature reactions (say, 40°–70° C) generally do not function at reduced temperatures (around 0° C). This is readily understood if peroxides are used as catalysts and thermal decomposition is relied upon to produce free radicals for initiating the polymerization (*6*). Accordingly, it would be highly desirable to employ some method to activate peroxide systems at low temperatures. If enough free radicals can be generated at low temperatures, then the reaction can be made to proceed with a practical over-all speed without losing high quality in the product.

If $[R\cdot]$ represents the total free radical concentration, and $[M]$ that for the monomer, then the over-all polymerization reaction rate will likely be given by

$$\frac{d[M]}{dt} = k[R\cdot][M],$$

where k is the specific reaction rate constant for chain growth. It is clear that the effective velocity is proportional to $k[R\cdot]$, so that even if k is reduced by lowering the temperature, $[R\cdot]$ might be sufficiently increased to compensate.

The necessary increase in $[R\cdot]$ can be brought about by reduction activation involving ferrous iron. In analogy to the conclusions of Haber and Weiss (*2*) on hydrogen peroxide, we can write (*13*) that

$$(RCOO)_2 + Fe^{++} \rightarrow RCOO^- + RCOO\cdot + Fe^{+++} \quad (1)$$

$$RCOO\cdot + Fe^{++} \rightarrow RCOO^- + Fe^{+++} \quad (2)$$

$$RCOO\cdot + M \rightarrow RCOOM\cdot \quad (3)$$

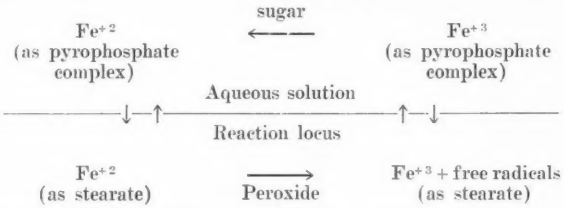
$$RCOOM_{n-1} + M \rightarrow RCOOM_n\cdot \quad (4)$$

$$RCOOM_n\cdot + (RCOO)_2 \rightarrow RCOOM_nR + RCOO\cdot + CO_2 \quad (5)$$

Reaction (1) is the desired reduction activation reaction. Ferrous iron rapidly reacts with peroxide to form acid ions, free radicals, and ferric iron. Reaction (2), which is not desired, involves the reduction of the free radical to a stable acid ion. In the presence of monomer, however, reactions (3) etc. can occur to form polymer. Reaction (5) is a modification reaction in which the peroxide acts as the modifier.

The reaction between ferrous iron and peroxides is very rapid, so that in practice certain additional controlling agents must be present. The benzoylperoxide redox system contains in addition to iron and peroxide some soap and pyrophosphate. The pyrophosphate appears to control the iron concentration by complex formation and the soap renders the iron capable of entering the reaction locus. Finally some reducing sugar is generally added to a redox system, so as to reduce (possibly by indirect means) the ferric iron back to the ferrous state.

Considerable evidence (*13*) leads one to believe that the iron undergoes a cycle as follows:



If pyrophosphate is absent, the reaction between the iron and peroxide is too fast; if soap is absent, the iron is not brought into contact with the peroxide, with the result that no reaction occurs. The peroxide is only slightly soluble in water, but can be present in the oil phase (monomer) or in the soap micelles distributed throughout the water.[2]

Locus of Reaction

The most significant contributions to our knowledge of the locus of reaction in emulsion polymerizations have been made by Harkins and co-workers (*3, 8*). These investigators have come to the following conclusions. Two types of loci are involved: (1) soap micelles in which the polymerization starts, and (2) the polymer particles themselves.

The soap micelles contain a core of oil and in that core the reaction starts. The polymer molecules thus started then grow into the aqueous phase (the soap becoming adsorbed to the polymer). By diffusion through the aqueous phase, monomer enters and dissolves in the polymer particles, thus providing more material for polymerization. Accordingly, most of the polymerization takes place in the polymer-monomer particles, and the monomer droplets in the emulsion serve only as reservoirs for reactants.

According to Harkins (*3*) the aqueous phase can serve as a secondary locus for initiation, but the particles so formed ultimately enter the second stage described above. As the reaction proceeds, the monomer droplets get smaller and smaller until at about 60 percent conversion (for GR-S) all the monomer is dissolved in polymer particles. After that the effective concentration of monomer in the reaction environment falls off rapidly, with the result that the kinetics soon depart from zeroth order.

It is significant that after 60 percent conversion the growing free radicals encounter relatively more polymer molecules and less monomer, with the result that branching and cross-linking then occur (*11, 12*).

[2] The author is indebted to Prof. I. M. Kolthoff of the University of Minnesota for pointing out that the reduction activation step occurs somewhere in the water layer, which is here presumed to be the oil core of the soap micelle. This interpretation is a modification of that given in (*13*).

References

1. Flory, P. J. *J. Amer. chem. Soc.*, 1937, **59**, 241.
2. Haber, F. and Weiss, J. *Proc. roy. Soc. Lond.*, 1934, **147A**, 332.
3. Harkins, W. D. *J. Amer. chem. Soc.*, 1947, **69**, 1428.
4. Kern, W. *Makromolekulare Chem.*, 1948, **B1**, 199.
5. Marvel, C. S. *et al.* *J. polym. Sci.*, 1948, **3**, 128.
6. Nozaki, K. and Bartlett, P. D. *J. Amer. chem. Soc.*, 1946, **68**, 1686.
7. Snyder, H. R. *et al.* *J. Amer. chem. Soc.*, 1946, **68**, 1422.
8. Stearns, R. S. and Harkins, W. D. *J. chem. Phys.*, 1946, **14**, 214.
9. Taylor, H. S. and Tobolsky, A. V. *J. Amer. chem. Soc.*, 1945, **67**, 2063.
10. Wall, F. T., Banes, F. W., and Sands, G. D. *J. Amer. chem. Soc.*, 1946, **68**, 1429.
11. Wall, F. T. and Beste, L. F. *J. Amer. chem. Soc.*, 1947, **69**, 1761.
12. Wall, F. T. *et al.* *J. Amer. chem. Soc.*, 1947, **69**, 904.
13. Wall, F. T. and Swoboda, T. J. *J. Amer. chem. Soc.*, 1949, **71**, 919.

Technical Papers

Terramycin, a New Antibiotic

A. C. Finlay, G. L. Hobby, S. Y. P'an, P. P. Regna, J. B. Routien, D. B. Seeley, G. M. Shull, B. A. Sobin, I. A. Solomons, J. W. Vinson, and J. H. Kane

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A new actinomycete, *Streptomyces rimosus*, has been isolated from a soil sample and so named because of the cracked appearance of the growth on the surface of an agar medium. When the organism was grown on plates containing nutrient agar and when a variety of bacteria including certain of the Gram-negative enteric organisms, aerobic spore-formers and Gram-positive cocci were streaked across these plates, growth of the test organisms was inhibited in the vicinity of the colony of the actinomycete. When *Streptomyces rimosus* was grown under submerged aerobic conditions, the broth exhibited similar inhibitory powers, as demonstrated in serial dilution assays. From broth cultures of this organism, a crystalline antibiotic was isolated; the name Terramycin has been assigned to this compound.

Terramycin is amphoteric and forms the crystalline hydrochloride and sodium salt. Crystalline Terramycin has the following properties: mp approximately 185° C with decomposition; $[\alpha]_D^{25} - 196°$ (1.0% in 0.1 *N* HCl). It is soluble in methanol, ethanol, acetone and propylene glycol, in water to the extent of 0.25 mg per ml at 25° C; insoluble in ether and petroleum ether. Terramycin is stable over long periods in aqueous solutions at about pH 2.0–3.0, at room temperature. A sample of crystalline Terramycin analyzed: C, 53.05; H, 5.91; N, 5.64; O (by difference), 35.4.[1]

Terramycin crystallizes in several forms, depending upon the procedure used. One of these forms consists of thick hexagonal plates, the refractive indices of which are $\alpha = 1.636 \pm .004$, $\beta = 1.644 \pm .004$, $\gamma > 1.700$.

In 0.1 M phosphate buffer (pH 4.5), Terramycin shows ultraviolet absorption maxima at approximately 247, 275, and 353 mμ. It also shows characteristic absorption in the infrared region.

The activity *in vitro* of crystalline Terramycin Hydrochloride against a variety of microorganisms is shown in Table 1. The activity was determined by dissolving varying amounts of the antibiotic in nutrient agar and streaking with the organisms under test. Further observations on the sensitivity of these and other organisms will be reported in detail elsewhere.

Terramycin shows a low degree of toxicity in animals. The intravenous LD_0 for Terramycin Hydrochloride is equivalent to 103 mg of the crystalline amphoteric compound per kg of body weight in mice; the LD_{50} is equivalent to 192 mg per kg.

[1] These determinations were made by Dr. John A. Means of Chas. Pfizer & Co., Inc., Brooklyn, New York.

TABLE 1

ACTIVITY *in Vitro* OF CRYSTALLINE TERRAMYCIN HYDROCHLORIDE*

Species	μg/ml	Inhibition
Acrobacter aerogenes	1.0	100%
Klebsiella pneumoniae	3.0	"
Escherichia coli	5.0	"
Salmonella typhosa	3.0	"
S. paratyphi	1.0	"
S. schottmuelleri	1.0	"
S. pullorum	10.0	"
Shigella paradysenteriae	1.0	"
Bacillus subtilis (FDA 219)	3.0	"
Staphylococcus albus	1.0	"
S. aureus	1.0	"
Proteus sp.	> 1000	"
Pseudomonas aeruginosa	100	"
Brucella bronchisepticae	3.0	"

* Activity is expressed in terms of the equivalent weight (μg) of crystalline Terramycin necessary to inhibit growth.

As is the case with aureomycin and chloramphenicol, Terramycin is active *in vivo* as well as *in vitro* and displays marked chemotherapeutic activity against experimental infections in mice due to *Streptococcus hemolyticus, Diplococcus pneumoniae, Klebsiella pneumoniae, Salmonella typhosa*, and other organisms. It is effective by both the oral and parenteral routes of administration. Preliminary studies suggest that Terramycin has definite antirickettsial activity in the chick embryo.[2] In high concentrations it appears to inhibit the infection of the chick embryo with the PR8 strain of Influenza A virus.

[2] Data on the antirickettsial activity of Terramycin will be reported elsewhere by Dr. John C. Snyder, Harvard School of Public Health.

The Oxygenation of Blood by Gas Dispersion

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In the attempts to relieve anoxia of the tissue by means other than those of artificial respiration or inhalation of gas mixtures high in oxygen, widely varying means of extrapulmonary oxygen administration have been employed. Oxygen has been injected subcutaneously, intraperitoneally, and intravenously, as well as directly into the intestines, the joints, the renal pelvis, and the urinary bladder. Oxygen has even been applied locally in attempts to increase the absorption through the skin. All

these methods have the disadvantage of supplying only a small fraction of the total oxygen consumption of the body, and, furthermore, the intravenous injection of oxygen is limited by the inherent danger of gas embolism (*22*).

For these reasons, attempts have been made for many years to construct an apparatus that would permit the introduction of an adequate amount of oxygen into the blood by circulating it through various devices designed to expose a large surface of blood to oxygen. The oxygenators devised have consisted of one (*12*) or more (*1, 6*) revolving disks, of chambers filled with glass beads (*4*), of spherical glass bulbs into which the blood was sprayed (*7*), of a revolving spiral sheet (*5*), and of a silk curtain through which blood was allowed to flow (*19*).

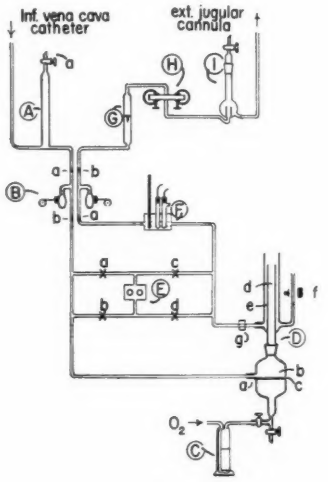

FIG. 1.

With the advent of thoracic and cardiac surgery, interest in the study of extracorporeal oxygenation of the blood was revived and efficient oxygenators consisting of one (*7–10*) or more (*15–17*) vertically revolving cylinders, a spiral tubing system (*13, 14*), and a series of conical disks (*21*) were developed. For perfusion of the brain with oxygenated blood, an instrument having 40 to 50 rotating disks, which dip into blood flowing through a trough, was described (*2, 3*).

In the present study, the old method of bubbling oxygen through blood (*20*), which had been discarded as too slow and foam-producing (*3*), was reinvestigated and found to be a very rapid and efficient procedure for saturation of hemoglobin under specific conditions. The oxygen is dispersed in the blood in the form of tiny bubbles produced by passing the gas through a fritted glass disk or a porcelain bacteriological filter. After oxygenation, which is nearly immediate, the excess gas is released by passing the blood over a surface coated with a methylpolysiloxane resin. The rate of oxygen flow is adjusted so as to produce optimum oxygenation without excessive flow of gas.

At the present stage of development the equipment shown in Fig. 1 is used. The dogs are anesthetized with sodium pentothal. Heparin (4 mg per kg initially and 1 mg per kg every half hour) is used as an anticoagulant. Blood pressure is recorded directly from a femoral or carotid artery, using a mercury manometer, and a pneumograph is used to record respiration rate. After filling the apparatus with fresh dog blood (about 500 ml is required) the blood is pumped from the animal through a polyethylene catheter inserted into the inferior vena cava through a femoral vein so that the tip lies near the big cardiac vein. The glass tube, *A*, serves to test the patency of the catheter by applying suction at A_a and also, by the use of a manometer connected to A_a, to give an indication of the reduced pressure being developed by the pump, *B*. The pump consists of two flexible polyethylene bottles (Plax Corporation, Hartford, Connecticut) which are alternately compressed and extended by means of a rod attached to an eccentric. Flap valves are placed at B_a and B_b.

The blood then enters the dispersion oxygenation apparatus *D* through a tube, D_a, fused to the glass at an angle so as to cause rapid swirling in chamber D_b. The capacity of chamber D_b is approximately 150 ml. Oxygen enters D_b through a gas-washing bottle *C*, containing water, which humidifies the gas and serves as an indicator of the gas flow. The gas is dispersed into tiny bubbles by the sintered glass plate, D_c, 90 mm in diam (porosity 5 μ, Corning Glass Works, Corning, New York). The gas may also be dispersed at a pressure of about 10 lb, by a porcelain filter candle (Catalog No. VFA-56, porosity 0.85 μ, Selas Corporation, Philadelphia 34, Pennsylvania). The dispersion of oxygen and blood then rises through tube D_d, which contains either fine glass rods or 3-mm glass beads coated with DC Antifoam A (Dow-Corning, Midland, Michigan). The blood then flows into chamber D_e, which has sufficient capacity to allow the remaining bubbles to escape to the surface. The level of blood is maintained at a constant level in this chamber by means of a photocell at D_f, which operates a magnetic valve at D_g.

Following oxygenation, the blood passes through a plexiglass block at *F* holding the large shielded Beckman pH electrodes and a thermometer. The blood circuit is arranged so as to facilitate measurement of the relative oxygen saturation of either venous or oxygenated blood by means of a modified oximeter (*15*) at *E*. Valves at E_{abcd} serve to by-pass a sample for the measurement of oxygen saturation. After passing through *F*, the blood is pumped into a rotameter, *G* (Size 2, Figure 27, Fischer and Porter Company, Hatboro, Pennsylvania), to give a continuous indication of flow rate, through a fine-meshed glass cloth filter, *H*, and into a bubble trap, *I*, which serves as an additional safeguard against gas emboli. The blood is returned to the animal through a cannula having a large bore (minimum 3.5 mm) inserted in an external jugular vein. All glass parts, including the glass cloth filter, but excepting the sintered glass disk, or the poree-

lain element, are coated with a silicone resin (Dri-Film No. 9987, General Electric Company, Schenectady, New York). Glass parts have also been given a permanent silicone surface by coating with a 2% solution of DC-1107 fluid (Dow-Corning Corporation, Midland, Michigan) in carbon tetrachloride, drying, and baking at 150° C for 30 min. Polyethylene tubing (0.236 in. inside diam and 0.326 in. outside diam, Surprenant Manufacturing Company, Boston, Massachusetts) is used throughout. Satisfactory connections between polyethylene tubing and glass tubing can be made by *carefully warming* the end of the plastic tubing over an open flame before sliding it over the glass. Before use, the apparatus is thoroughly washed by the circulation of Dakin's solution and sterile saline. The entire equipment is mounted in a plexiglass cabinet equipped with a device to circulate air at about 40° C.

TABLE 1

Dog No.	Weight	Mean blood flow	Change in mean arterial blood pressure	Change in heart rate	Change in respiratory rate	Duration of nitrogen inhalation
	kg	ml/min	mm Hg	%	%	min
1	10.0	300	− 5	+21	+ 37	7
2	16.0	500	−15	+ 8	+ 22	12
3	12.0	500	−30	0	0	20
4	12.0	200	−40	+ 9	+ 20	25
5	10.0	320	−50	+12	+ 33	58
6	10.0	500	−33	+21	+ 83	15
7	12.0	500	−15	0	− 20	32
8	14.4	600	...	...	+ 10	26
9	11.7	450	− 3	0	− 8	99
10	9.0	530	...	...	0	30
11	11.7	460	−10	+10	+ 6	60
12	6.8	350	− 5	0	+143	28
13	9.1	350	−16	0	+ 87	60
14	9.1	250	0	0	0	8
15	9.0	500	− 2	0	− 11	90

In order to test the efficiency of the oxygenation apparatus, the dogs were allowed to breathe 100% nitrogen through a tight-fitting transparent plastic mask. Pumping of oxygenated blood preceded the administration of nitrogen by 5 to 10 min. During the period of pumping, hemolysis increased slowly and occasionally reached values of 0.4 g/100 ml of plasma. There occurred also a drop in leukocyte count, owing mainly to a destruction of granulated cells.

Table 1 shows the periods of nitrogen inhalation that 15 consecutive dogs survived while the blood was circulated through the oxygenator at the rate indicated. In dog No. 9, the period of nitrogen inhalation was extended for 99 min. The acute rise in blood pressure, always associated with acute anoxic anoxia, was completely prevented. In most instances the heart rate and respiratory rate showed moderate increases. Electrocardiograms taken during the inhalation of nitrogen were compared with the tracings before and after the experiment and failed to show any signs of general anoxemia, like diminutions of the T and R wave or depression of the S-T segment.

The high degree of oxygen saturation of the blood leaving the apparatus was always apparent, since the striking bright red color stood in great contrast to that

TABLE 2

Source of blood	28-Min period of nitrogen breathing		88-Min period of nitrogen breathing	
	O_2 saturation %	pH	O_2 saturation %	pH
Venous blood to apparatus	58.8	7.32	63.1	7.15
Oxygenated blood from apparatus ...	98.0	7.38	...	...
Carotid artery	83.2	7.30	97.1	7.00

dark blood entering the apparatus from the vein, and even to that visible in the carotid cannula, used to record blood pressure. The oximeter readings have consistently indicated the saturation to be above 95% and the Van Slyke analyses, reported in Table 2, for a typical experiment reveal an entirely satisfactory saturation of the blood in the carotid artery. These samples were collected *while the dog was breathing 100% nitrogen.* The constancy of the blood pH indicates that carbon dioxide was released at the same rate oxygen was absorbed.

If the pump is stopped during the inhalation of nitrogen, respiratory arrest occurs within 40 sec.

References

1. Bayliss, L. E., Fee, A. R., and Ogden, E. *J. Physiol.*, 1928, **66**, 443.
2. Bjork, V. O. *Lancet*, 1948, **2**, 491.
3. ———. *Acta chir. Scand.*, 1948, **96**, Suppl. 137.
4. Bornstein, A. *Arch exp. Path. Pharmak.*, 1926, **115**, 367.
5. Cruikshank, E. W. H. *J. Physiol.*, 1934, **82**, 26.
6. Daly, I. de B. and Thorpe, W. V. *J. Physiol.*, 1933, **79**, 199.
7. Euler, U. S. von and Heymans, C. *J. Physiol.*, 1932, **74**, 2.
8. Gibbon, J. H., Jr. *Arch. Surg.*, 1937, **34**, 1105.
9. ———. *Surg. Gynec. Obstet.*, 1939, **69**, 602.
10. ———. *J. lab. clin. Med.*, 1939, **24**, 1192.
11. Gibbon, J. H., Jr. and Kraul, C. W. *J. lab. clin. Med.*, 1941, **26**, 1803.
12. Hooker, D. R. *Amer. J. Physiol.*, 1915, **38**, 200.
13. Jongbloed, J. *Ned. Tijdschr. Geneesk.*, 1948, **92**, 1065.
14. ———. *Ned. Tijdschr. Geneesk.*, 1949, **93**, 548.
15. Karlson, K. E., Dennis, C., and Westover, D. E. *Proc. Soc. exp. Biol. Med.*, 1949, **70**, 223.
16. ———. *Proc. Soc. exp. Biol. Med.*, 1949, **70**, 225.
17. Karlson, K. E. *et al. Proc. Soc. exp. Biol. Med.*, 1949, **71**, 204.
18. Millikan, G. A. *Rev. sci. Instr.*, 1942, **13**, 434.
19. Richards, A. N. and Drinker, C. K. *J. Pharm. exp. Therap.*, 1915, **7**, 467.
20. Schroder, W. *Arch. exp. Path. Pharmak.*, 1882, **15**, 364.
21. Thomas, J. A. *J. de physiol.*, 1948, **40**, 123.
22. *Bibliography on oxygen therapy.* New York: Linde Air Products Co., 1947.

Use of Dried Bovine Hemoglobin Powder in the Anson and Mirsky Methods for Pepsin and Trypsin[1]

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As originally reported by Anson and Mirsky (*1*, *2*), the preparation of hemoglobin substrate used in the determination of pepsin and trypsin is a time-consuming, cumbersome procedure. It requires such equipment as a lyophilizer and a freezing unit, which is not available in many laboratories. Although the procedure for preparation of the pepsin substrate was much simplified by Bucher *et al.* in 1945 (*3*), it nevertheless still retains many tedious steps—for example, it requires quantities of fresh beef blood, and large volumes of solution must be centrifuged, dialyzed, and so on. Therefore, after our experiences with preparation of hemoglobin solution from defibrinated beef blood according to Bucher *et al.*, we sought a more convenient and equally reliable method. Through the kindness of Dr. J. B. Lesh, of the Chemical Research and Development Department, Armour and Company, we were provided with samples of lyophilized bovine hemoglobin, which had been prepared as directed by Mirsky. We have been using such preparations[2] since 1946, and have found them entirely satisfactory. The pepsin determinations using this material have been reproducible and reliable, there being no systematic difference between results obtained on the same specimens of human stomach contents with the Bucher substrate and the one herein described. Having had such satisfactory results with the acidified substrate for pepsin determinations, we proceeded to modify the alkaline substrate for trypsin described by Anson (*1*) to utilize this dried hemoglobin preparation. Details for the preparation of the substrate solutions for each of these enzymes are as follows:

Pepsin substrate solution. To prepare 1 l of final solution containing 2.5% hemoglobin, about 30 g of the powder is weighed out in a beaker and made into a smooth paste with a small quantity of water. Then more water is added and thoroughly mixed until the solution is thin enough to be poured readily. The solution is transferred to a 500-ml volumetric flask, diluted to the mark with distilled water, and filtered. The hemoglobin concentration of the filtrate is estimated by the dry-weight assay method described by Anson (*1*). A quantity of this concentrated solution (5%–6%), which contains exactly 25 g of hemoglobin, is transferred to a 1-l volumetric flask, 25 ml of merthiolate (1: 1000) is added as a preservative, and the volume is made up with distilled water. The solution is stored in the refrigerator.

Trypsin substrate solution. In order to prepare 1 l of hemoglobin substrate solution to be used in the trypsin determination, 500 ml of a 5%–6% solution of hemoglobin powder is made up and assayed, following the procedure for the pepsin substrate concentrate. Of this concentrate, a volume calculated to contain exactly 22 g of hemoglobin is introduced into a 1-l volumetric flask together with 80 ml 1 *N* NaOH, 400 g urea, and sufficient water to bring the total volume to about 800 ml. After thorough mixing, the solution is incubated at 25° C for 30–60 min to denature the protein. To the solution is then added 100 ml 1 M potassium dihydrogen phosphate, 20 ml merthiolate (1:1000), and sufficient water to bring the volume up to 1 l. After mixing and filtering, the substrate solution (pH 7.5) is stored in the refrigerator.

In summary, substrate solutions for the determination of pepsin and trypsin according to the methods of Anson and Mirsky have been prepared from dried bovine hemoglobin powder, instead of from fresh blood. Using this modification, the tedious steps in preparation of pure hemoglobin in the laboratory have been eliminated, without effecting the reliability of the analytical results. Small quantities can now be made up at any time, obviating the possibility of deterioration on standing. It is hoped that with this modification these enzyme methods will find wider use in clinical as well as in experimental laboratories.

[1] Supported in part by grant from Altman Foundation.

[2] Now commercially available from the Chemical Research and Development Department, Armour and Company, Chicago 9, Illinois, under the designation, Bovine Hemoglobin Enzyme Substrate Powder.

References

1. Anson, M. L. *J. gen. Physiol.*, 1938, **22**, 79.
2. Anson, M. L. and Mirsky, A. E. *J. gen. Physiol.*, 1932, **16**, 59.
3. Bucher, G. R., Grossman, M. I., and Ivy, A. C. *Gastroenterology*, 1945, **5**, 501.

Response of the Guinea Pig to 200 Roentgens Acute Whole Body X Irradiation[1]

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The hematological response of many animal species to ionizing radiations has recently been presented by Jacobson, Marks, and Lorenz (*5*). However, their description of the response of the guinea pig did not present a complete picture of the effect of acute x irradiation on this animal.

The guinea pig has been used in the study of the effect of drugs upon x irradiation mortality (*2*) but no description was given of the effect of either drugs or radiation upon the leukocyte and differential counts, the coagulation time, or the body weight curve. All of these are of importance in determining the response of the guinea pig to x irradiation and can be used as indicators of radiation damage.

[1] This paper is based on work performed under Contract No. AT-04-1-GEN-12 between the Atomic Energy Commission and the University of California at Los Angeles.

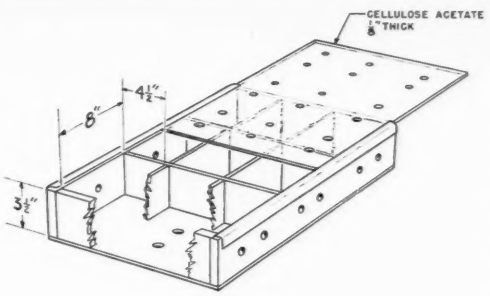

FIG. 1.

We have studied the effect of 200 r acute whole body x irradiation (approximately LD_{50}) upon the guinea pig in conjunction with an evaluation of several antihistaminic agents (*4*). The animals were caged in an irradiation chamber, Fig. 1, and the following radiation factors were employed: 250 kv, 15 ma, target subject distance 100 cm, filters 0.21 mm Cu inherent, 0.5 mm Cu parabolic and 1.0 mm Al, half-value layer 1.85 mm Cu, size of field —total body, r/min measured in air 9.48–10.61. Uniformity of dosage was insured by rotating the radiation cage during the treatment. The 250-kv Picker Industrial Unit used was calibrated before each experiment with a Victoreen thimble r-meter. The male guinea pigs, weighing 255–585 g (average 365 g) were divided into equal groups, usually ten animals each. In all, 66 controls and 64 irradiated animals were used. Total leukocyte and differential counts, coagulation time, and body weight were determined twice weekly until the irradiated animals showed signs of recovery. The radiation dosage used varied in lethality from 33% to 90% per group in the seven groups tested, but the average was 62.5%.

Comparison of the values in Table 1 indicates that our normal control animal compared favorably with those reported by Gardner (*3*). Also, comparison of our data with that reported in the literature for other rodents (*5, 6*) shows that the guinea pig is not different in its response to x irradiation. Absolute values in the differential count are a better comparison of the actual state of the animals than relative ones. This is particularly evident with eosinophils, basophils, and monocytes, where relative values indicate no change but absolute ones show decreases of approximately 50% of preradiation values. The lymphocytopenia and neutropenia begin after the third postirradiation day and recovery is not evident until the 14th postirradiation day. Although the lymphocyte is the least resistant of the leukocytes to x irradiation, we did not observe such a drastic reduction as has been reported for the rabbit (*5*) and the rat (*6*). However, we did not make our first counts until the third postirradiation day, and this may account for our findings. Throughout the period of greatest depression, postirradiation days 5–14, there was a definite shift to the immature forms in the differential count. In all the irradiated animals the lymphocytes showed a faster recovery than the neutrophils. This is identical with the response of other animal species. From the 16th postirradiation day there was a definite increase in the proportion of neutrophils to lymphocytes. The neutrophils showed both higher relative and absolute values than at the beginning of the experiment, while the lymphocytes showed decreased values. This is to be expected because the animal is overproducing its leukocytes and attempting to regain a normal hematological balance.

TABLE 1

LEUKOCYTES IN THE NORMAL AND X-IRRADIATED GUINEA PIGS

Cells		Reported in Literature (*3*)		Normal animals		Before irradiation		Irradiated animals					
								3rd day after		9th day after		16th day after	
		Range	Avg	Range	Avg	Range	Avg	Range	Avg	Range	Avg	Range	Avg
Leukocytes		5700 to 17365	9800	7450 to 10,530	9910	8895 to 13,431	10,353	4820 to 8957	7867	3864 to 6480	4680	10,350 to 18,100	10,755
Lymphocytes	R*	39.4–63.6	53.81	55–65	61	59–67	60	59–73	64	77–89	85	42–60	51
	A†	.....	5194	.....	6045	.....	6211.8	.....	4934.88	.....	3978	.....	5495.25
Neutrophils	R	31.1–53	40.89	33–41	37	31–39	35	25–39	34	12–23	17	36–56	46
	A	.....	3920	.....	3666	.....	3623.55	.....	2674.78	.....	795.6	.....	4956.5
Eosinophils	R	1.99–3.5	2.65	0–3	1.5	0–3	1.5	0–3	1.5	0–3	1.5	0–3	1.5
	A	.....	294	.....	148.65	.....	155.3	.....	118	.....	70.2	.....	161.63
Basophils	R	0.49–0.7	0.45	1–3.5	2.0	1–2	1.5	1–2	1.5	1–2	1.5	1–2	1.5
	A	.....	44.1	.....	198.2	.....	155.3	.....	118	.....	70.2	.....	161.63
Monocytes	R	1.5–8.2	2.89	1–2	1.5	1–3	1.8	1–3	1.8	1–3	1.8	1–3	1.8
	A	.....	294	.....	148.65	.....	186.35	.....	141.6	.....	84.24	.....	193.95

* R—relative number.

† A—absolute number.

As we were using multiple determinations, we employed the capillary tube method for determining coagulation time. Other methods are more accurate but they employ cardiac puncture for obtaining the blood specimen and thus would be highly detrimental to irradiated guinea pigs. Coagulation time in normal control animals ranged from 127 to 168 sec (average 146 sec). The irradiated animals began the experiment in this range but by the ninth postirradiation day their coagulation times had in-

creased to an average of 233 sec. However, in the animals that recovered, the final value varied between 136 and 140 sec. This prolonged coagulation time was probably one of the contributing factors in the skin hemorrhages seen in all irradiated animals. However, although we only estimated the total number of platelets in our differential counts, the decreased number of platelets found was probably a factor in the increased coagulation time and should be considered, as should the possibility of hyperheparinemia (*1*).

The normal control animals showed a progressive weight gain throughout the experiment, whereas the irradiated animals lost weight (up to 100 g/week) beginning on the fifth postirradiation day and continuing until the 16th day, after which time those that survived began gaining weight faster than the controls.

In 13 irradiated animals, autopsy showed varying degrees of intestinal damage, from rupture to complete dissolution of parts of the small intestine. Intestinal damage is a general finding after x irradiation (*7*) and was probably one of the reasons for the weight loss observed in the irradiated animals.

It is concluded that the guinea pig responds similarly to other animals subjected to x irradiation and that for many purposes is much more suitable for such studies than the mouse or rat. Dependable results can be obtained using the guinea pig because its size and general temperament are suitable for studies employing large numbers of animals. However, all hematological studies should be reported in both relative and absolute terms to avoid a misinterpretation of the results observed.

References

1. Allen, J. G. and Jacobson, L. O. *Science*, 1947, **105**, 388.
2. Clark, W. G., Uncapher, R. P., and Jordan, M. L. *Science*, 1948, **108**, 629.
3. Gardner, M. V. *J. Franklin Inst.*, 1947, **243**, 498.
4. Haley, T. J. and Harris, D. H. *UCLA-28*, June 1949.
5. Jacobson, L. O., Marks, E. K., and Lorenz, E. *Radiology*, 1949, **52**, 371.
6. Lawrence, J. S., Dowdy, A. H., and Valentine, W. N. *Radiology*, 1948, **51**, 400.
7. Warren, S. L. *Biological effects of radiation*. New York and London: McGraw-Hill, 1936. Pp. 473–539.

Persistence of 2,4-D in Plant Tissues

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The persistence of 2,4-D in plant tissues of seedlings produced from plants which exhibited 2,4-D injury has been reported by several writers. Pridham (*3*) found that, if bean plants were sprayed with 2,4-D while the pods were still green, seedlings from seeds from these pods developed malformations characteristic of those produced by 2,4-D. Brown, Holdeman, and Hagood (*1*) reported that no abnormalities were found in cotton seedlings from seed collected in Louisiana in cotton fields affected by 2,4-D. Dunlap (*2*) reported that abnormal root development and deformed leaves were produced by seed collected from cotton plants that exhibited 2,4-D symptoms the year before. No other reports, to the writers' knowledge, have been published that would indicate any persistence of 2,4-D in plant tissues from one growing season to the next other than in seeds.

Fig. 1. On right, 2,4-D injury to shoot of *Stillingia sebifera*. Healthy shoot on left.

In the spring of 1949, trees of the Chinese Tallow tree, *Stillingia sebifera* Michx., growing in the vicinity of Beaumont, Texas, were observed to be producing shoots with symptoms characteristic of 2,4-D injury (Fig. 1). These trees had been accidentally injured with 2,4-D during the summer of 1948. Other trees of this variety were also observed that were purposely sprayed in 1948 in an attempt to kill them. Of 100 trees in this group that were examined, 14 were dead, and all of the rest showed characteristic symptoms of 2,4-D injury. No 2,4-D had been used in 1949, and the symptoms of injury appeared on the earliest growth. This indicates that the 2,4-D had persisted in the buds and other vegetative tissues of this plant from the time of injury in 1948. Some chinaberry trees, *Melia Azedarach* L., were also severely injured in the vicinity of Beaumont, Texas, in 1948, but no symptoms of 2,4-D injury were found on them in 1949, which indicates that 2,4-D does not persist in the vegetative tissues of this plant.

References

1. Brown, C. A., Holdeman, Q. L., and Hagood, E. S. *La. Bull.* No. 426, 1948.
2. Dunlap, A. A. *Phytopath.*, 1948, **38**, 638.
3. Pridham, A. M. S. *Science*, 1947, **105**, 412.

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Use of 2,4-D as an Inhibitor of Germination in Routine Examinations of Beans for Seed-Borne Infection[1]

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During the examination of samples of bean seed, *Phaseolus vulgaris* L., difficulties were experienced in determining the percentage of seeds infected with *Colletotrichum lindemuthianum* (Sacc. and Magn.) Bri. and Cav. The method of examination used was that described by

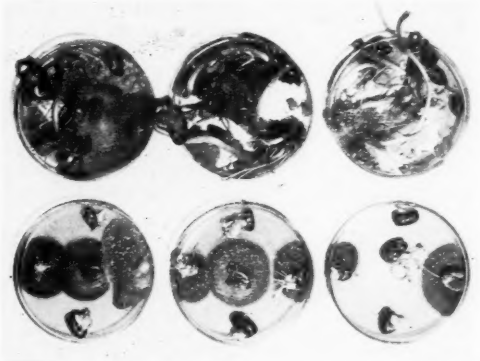

FIG. 1. Surface-sterilized bean seeds incubated 14 days at 20–25° C on malt extract agar. Upper row, unmodified medium; lower row, medium containing 50 ppm of sodium 2,4-dichlorophenoxyacetate.

Groves and Skolko (*2*). This method proved to be quite suitable for seeds of plants with hypogeal cotyledons, but somewhat unsatisfactory for bean seeds. With beans, the agar became cracked and displaced, and the hypocotyls elongated to such an extent that the cotyledons became displaced from their original positions on the agar. At the end of the period of incubation, it was difficult to ascertain from which of the seeds the pathogen had developed (Fig. 1, lower row).

Attempts were made to inhibit seed germination coincident with adequate development of the pathogen. Incubation at a reduced temperature was only partially effective, but chemical inhibition of germination proved to be very effective. Hamner, Moulton, and Tukey (*3*) have shown that traces of 2,4-dichlorophenoxyacetic acid in soil can affect the germination and growth of many seeds, including beans. Accordingly, additions were made to the culture medium of either this chemical or its sodium salt, sodium 2,4-dichlorophenoxyacetate. The sodium salt resulted in less hydrolysis of the agar during autoclaving and therefore proved to be the more satisfactory of the two chemicals. When it was included in the nutrient medium at a concentration equivalent to 25–300 ppm of the acid, germination of the bean seeds was strongly inhibited.

It was found that low concentrations of the chemical would inhibit germination without causing any observable retardation of the growth of *C. lindemuthianum*. Bever and Slife (*1*) reported retardation or killing of *Pythium debaryanum*, *Gibberella zeae*, and *Helminthosporium victoriae* by 2,4-D in concentrations between 250 and 2000 ppm of the active acid. In the present study some retardation of *C. lindemuthianum* was found at concentrations above 100 ppm, but none at lower concentrations. It was also evident that there were strains of this pathogen that differed from one another in respect to their tolerance for higher concentrations of 2,4-D.

The results of repeated tests appear to warrant the use of 50 ppm, acid equivalent, of sodium 2,4-dichlorophenoxyacetate in culture media used for routine examination of bean seeds for infection with *C. lindemuthianum*. A satisfactory medium has the following composition: malt extract 20 g, agar 15 g, added to 1000 ml of solution containing 50 ppm, acid equivalent, of sodium 2,4-dichlorophenoxyacetate. This medium has a pH of 4.7 as determined by means of a Beckman glass electrode pH meter.

References

1. BEVER, WAYNE M. and SLIFE, F. W. *Phytopath.*, 1948, **38**, 1038.
2. GROVES, J. W. and SKOLKO, A. J. *Canad. J. Res.*, 1944, C, **22**, 190.
3. HAMNER, C. L., MOULTON, J. E., and TUKEY, H. B. *Bot. Gaz.*, 1946, **107**, 352.

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Relation between Band Slicks at the Surface and Internal Waves in the Sea[1]

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Band slicks on the sea surface like those shown in Fig. 1 are commonly seen along the shore when the wind is a light breeze. Dietz and La Fond (*1*) of the Naval Electronics Laboratory in San Diego, California, have observed such slicks in coastal waters of California, Australia, and Samoa, around the Marquesas Islands, and near the Antarctic ice pack. Woodcock and Wyman (*6*) have observed and photographed similar "bands of light and dark appearance" in the Gulf of Panama. They attrib-

[1] Contributions from New Series, No. 448, Scripps Institution of Oceanography.

[2] The author is grateful to the Naval Electronics Laboratory, San Diego, for the loan of equipment.

uted the effect to a systematic variation in the pattern of small waves on the sea surface associated with a corresponding variation in wind speed, which they explained in terms of roll vortices caused by convection in the air or in terms of an internal wave in the air caused by wind shear near the sea surface. They observed the effect at all wind speeds up to 7.5 m per sec and described the bands as oriented with their long axes roughly parallel to the wind.

FIG. 1. Typical band slicks.

Dietz and La Fond (*1*) have found that the primary mechanism controlling the formation of slicks in bands is a film of some substance at the sea surface which lowers the surface tension in the bands where ripples are absent, the role of the wind in this connection being merely to generate ripples which reveal the peculiar disposition of the surface film. A secondary mechanism must be sought to explain why the surface film is unevenly distributed. Detailed observations by the writer have revealed that at least two such distributive mechanisms are in operation: one, which dominates when the wind is absent or light, is associated with internal waves in a shallow thermocline under the sea surface; the other, which dominates at higher wind velocities, is controlled by processes in the air, such as Woodcock and Wyman (*6*) describe. In order to keep the two cases distinct, slicks formed by the first process will in this report be called internal wave slicks, and those formed by the second will be called wind slicks. Internal wave slicks form over the troughs of internal waves, travel with the waves, and are oriented with their long axes parallel to the wave troughs without respect to wind direction. Wind slicks, on the other hand, are independent of internal waves in the sea and are oriented in an approximately downwind direction. The transition from one regime to the other occurs roughly when the wind speed is greater than 3.5 m per sec, i.e., the speed necessary to straighten out light flags and to keep leaves and twigs in constant motion.

More work will be needed to confirm the relationship between band slicks and internal waves, but the evidence so far is convincing enough to warrant a preliminary report. The evidence presented is of two sorts: first, in the series of simultaneous bathythermograph and slick observations shown in Fig. 2, the slicks coincide in every case with depression of the 60° F isotherm and the rippled zones coincide with elevation of the isotherm; and second, when, as in Table 1, the most significant of the

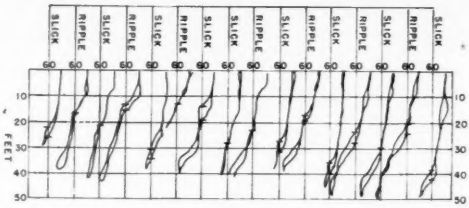

FIG. 2. A series of bathythermograms taken in rapid succession from a moving ship together with simultaneous observations of internal wave slicks, showing the elevations and depressions of the 60° F isotherm in relation to the presence of ripples or slicks at the surface.

observed characteristics of internal wave slicks are arrayed against the oceanic phenomena to which they may readily be attributed, it is seen that short period internal waves give the simplest explanation of the observations, since this phenomenon by itself can account for all the listed characteristics, whereas, of the remaining phenomena in the table, no less than four must be supposed to be operating in concert to account for the complete list.

Before discussing Table 1 in detail, a brief résumé of the known properties of internal waves will be given, together with a suggested mechanism to account for the uneven disposition of surface-active materials. Fig. 3 is a diagrammatic representation of an internal wave in the thermocline between two layers of water of nearly equal density, where the wavelength is great compared to the thickness of either layer. Internal waves of this type are described by Lamb (*3*), Sverdrup (*4*), Ufford (*5*), Haurwitz (*2*), and others. The fundamental feature

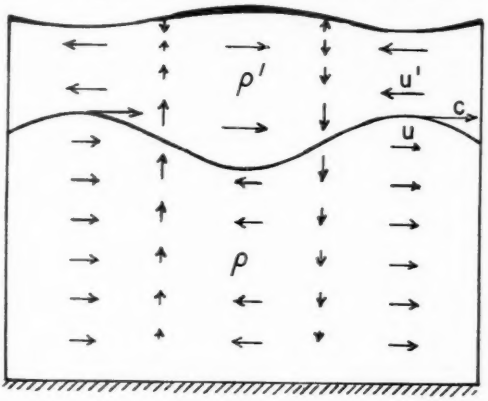

FIG. 3. Schematic diagram of an internal wave in two layers of water of nearly equal densities, ρ' and ρ, where the wavelength is large compared to the thickness of either layer. Shown are the phase velocity, c, the horizontal particle velocities in the upper and lower layers, u' and u, and the associated vertical velocities. The surface layer is alternately thickened and thinned because of the convergence and divergence of u'. This effect, as well as the amplitude of the wave at the surface, has been much exaggerated for purposes of illustration. (After Sverdrup.)

causing internal waves to behave differently from ordinary surface waves is the presence over the wave of a fluid nearly as dense as that below. Because of this the potential energy associated with a given deformation is much reduced, while the inertia of the system as a whole is increased. Consequently, when an internal wave is compared to an ordinary surface wave of similar length, it is found that the speed of propagation, or phase velocity, of the internal wave is diminished in the ratio $\{(1-s)/(1+s)\}^{1/2}$, where s is the ratio of the density of the upper to that of the lower fluid. For the usual case in the sea, this factor is of the order of 10^{-2}. The orbital motion of individual water particles for the case diagrammed in Fig. 3 is in opposite sense in the two layers. In the upper layer, the orbits are ellipses whose horizontal axes are uniform throughout the layer and whose vertical axes vary inversely with the distance above the thermocline. Thus the horizontal component of particle motion is the same at all depths in the upper layer, being in the direction of wave propagation over the trough of the wave and in the opposite direction over the crest.

TABLE 1

RELATION OF OCEANIC PHENOMENA TO OBSERVED CHARACTERISTICS OF BAND SLICKS

Oceanic phenomenon	Characteristics of band slicks							
	Banding (1)	$c \approx 25$ cm/sec (2)	u' oscillates* (3)	$u'_{max} \rightarrow c$ (4)	$T \approx \frac{1}{3}$ hr (5)	Persistence (6)	Refraction (7)	Independence of wind (8)
Transport by wind or current			X			X		
Transport by surface waves	X*		X		X			
Internal waves in the air							X	X
Roll vortices in the air							X	X
Surface waves, swell, seiche		X		X				
Tides, as waves	X	X			X	X		
Internal waves in water	G†	G	G	G	G	G	G	G

* X = bad fit.
† G = good fit.

The vertical component of particle motion, on the other hand, is comparable to the horizontal component only at the thermocline, decreasing rapidly above this level and vanishing at a depth of a centimeter or so below the free surface. At still higher levels the vertical motion is reversed, so that, at the free surface, there exists a wave of very low amplitude exactly out of phase with the wave at the thermocline. It can be seen in Fig. 3 that the horizontal particle velocities are convergent wherever the thermocline is descending and divergent wherever the thermocline is rising. The convergence is most intense halfway between crest and trough, but its cumulative effect is greatest over the trough of the lower wave. Thus, if the water above the thermocline were imagined divided into a number of layers, each layer would be thickest over the trough of the wave and thinnest over the crest. This effect, acting on a surface film of initially uniform thickness, would distort it into alternate bands of greater thickness over the wave trough and less thickness over the wave crest. Thus a slick would be formed by temporary thickening of the surface film in a given area during the time the trough of an internal wave was passing beneath it. The zone of thickening, rather than the material itself, would thus progress with the internal wave. The effect of a wind-driven current on this mechanism would depend on the size of its cross-slick component. For small values, it would merely displace the slick with reference to the trough. At critical values it would cause the slick material to drift with the wave so that the material in a given slick would remain the same. At values greater than the critical, the wind-driven current would completely dominate the slick material and would then produce wind slicks nearly independent of internal waves, in the manner described by Woodcock and Wyman (*6*).

The characteristics of wave slicks listed in Table 1 are based on the following observations:

1. *Banding.* The slicks are about 30 m wide and often many kilometers long. They lie in roughly parallel deployment, as bands of clouds sometimes do, separated by zones of ripples about 300 m wide. Ufford (*5*) found internal waves off San Diego of from 100- to 400-m length between crests.

2. *Slick velocity, $c \approx 25$ cm/sec.* Time-motion studies show that internal wave slicks often move in a direction perpendicular to their long axes at a uniform and steady speed of about $\frac{1}{2}$ knot. This velocity is relatively greater in deep water. Ufford (*5*) found the phase velocity of internal waves to be from 0.07 to 0.68 knots.

3. *Particle velocity, u', oscillates.* Floating objects execute oscillatory motion perpendicular to the long axis of a passing slick. They are drawn into the oncoming slick, held in the slick for a time, and finally expelled to the rear, nearly resuming their initial position.

4. *Maximum horizontal particle velocity, $u'_{max} \rightarrow c$.* Objects, while floating in a slick, advance for a time at a speed significantly comparable to the phase velocity. Such high particle velocities are characteristic of internal waves.

5. *Period, $T \approx \frac{1}{3}$ hr.* Internal wave slicks usually move past a point at intervals of from 15 to 30 min. Ufford found internal waves with periods from 9 to 136 min.

6. *Persistence.* Slicks persist in spite of horizontal eddy diffusion. This shows that they are continually maintained by a disturbance moving with the slick.

7. *Refraction.* Internal wave slicks, in water less than 20 m deep, are oriented approximately parallel to the bottom contours. Thus upon approaching submarine canyons, for example, they are bowed into the canyons in the manner of long period swell. The speed of internal waves depends partially on the water depth below the thermocline. For the case described above the speed is given by:

$$c^2 = g \frac{h h'}{h + h'} \frac{\varrho - \varrho'}{\varrho}$$

where h refers to the thickness of the layers ϱ refers to their densities and the primes refer to the upper layer.

8. *Independence of wind.* In the absence of wind, band slicks are not visible because there are no ripples, but floating objects are often observed to be marshalled in long rows at the sea surface. As soon as the wind arises it is seen that slicks form along these rows. At wind velocities less than about 3.5 m per sec the orientation of the slicks is independent of wind direction.

References

1. Dietz, R. S. and La Fond, E. C. Manuscript, 1949.
2. Haurwitz, B. *J. Marine Res.*, 1948, **7**, 224.
3. Lamb, H. *Hydrodynamics.* New York: Dover, 1945. P. 372.
4. Sverdrup, H. U., Johnson, M. W., and Fleming, R. H. *The oceans.* New York: Prentice-Hall, 1946. P. 585.
5. Ufford, C. W. *Trans. Amer. geophys. Union*, 1947, **28**, 87.
6. Woodcock, A. H. and Wyman, J. *Ann. N. Y. Acad. Sci.*, 1947, **48**, 749.

β-3-Thienylalanine, an Antiphenylalanine in the Protein-depleted Rat[1]

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Most studies of the effects of amino acid antagonists on mammalian metabolism have been made with young growing rats (*1, 3*). Since the protein-depleted rat regains weight rapidly on a synthetic diet containing all the essential amino acids (*2*), it seemed to us that this uniformly selected animal should be useful for the study of amino acid antagonists. At this time we wish to report the effect of β-3-thienylalanine (β-3-TA) on the recovery of the protein-depleted rat.

TABLE 1

Composition of Basal (MEA) Diet

	%		%
Dextrin	61.14*	Essential amino acids†	3.93
Corn Oil	4.00	Nonessential amino acids‡	4.93
Fiber	5.00	Vitamins in dextrin	1.00
O-M Salt Mix§	4.00	Water	16.00

* Various addenda were made by reducing the content of dextrin by a corresponding amount.

† Composition of the essential amino acids in this mixture was: L-histidine-HCl, 4.91%; DL-isoleucine, 20.69%; L-leucine, 12.29%; L-lysine-HCl, 13.49%; DL-phenylalanine, 7.63%; DL-threonine, 14.58%; DL-tryptophane, 2.47%; DL-valine, 17.30%; DL-methionine, 6.62%.

‡ Composition of the nonessential amino acids in this mixture was: DL-alanine, 11.71%; L-arginine-HCl, 10.37%; DL-aspartic acid, 13.17%; L-cystine, 0.75%; L-glutamic acid, 49.57%; glycine, 1.06%; and L-tyrosine, 13.37%.

§ Osborne and Mendel salt mix.

[1] This work was supported in part by research contracts with the Office of Naval Research.

[2] Research guest on academic leave from the Department of Chemistry, University of Colorado, during the period of these investigations.

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Albino male rats of the Sprague-Dawley strain with initial weights varying from 211 g to 227 g were selected. They were depleted of protein according to procedures previously described (*5*), and selected for the experiment when their weight loss was between 26% and 35%. During the first two days of the experimental period all animals in individual cages were offered 15 g of the basal diet containing the minimum amounts of the essential amino acids required for optimum restoration of lost weight (*4*). The composition of this diet, designated MEA, is given in Table 1. After two days on the MEA diet, 12 rats were divided into four groups of three animals each. Each animal in the four groups received the dietary treatment as outlined in Table 2.

TABLE 2

Dietary Treatment of Each Group of Rats

Group 1	MEA for 10 days.
Group 2	MEA for 2 days; MEA plus 90 mg phenylalanine for 8 days.
Group 3	MEA for 2 days; MEA plus 50 mg β-3-TA for 1 day; MEA plus 25 mg β-3-TA for 2 days; MEA plus 25 mg β-3-TA and 90 mg phenylalanine for 5 days.
Group 4	MEA for 2 days; MEA plus 200 mg β-3-TA for 2 days; MEA for 2 days; MEA plus 25 mg β-3-TA for 4 days.

The average changes in body weight of each group of animals are plotted in Fig. 1. It may be seen that the animals of groups 1 and 2 gained equal amounts of body weight, indicating that twice the level of phenylalanine did not alter the weight restoration.

The addition of 50 mg of β-3-thienylalanine to the diet resulted in a loss of weight and a decrease in appetite. All animals continued to lose weight when the amount of β-3-TA was reduced to 25 mg per 15 g of diet. When 90 mg of phenylalanine was added with 25 mg β-3-TA, all

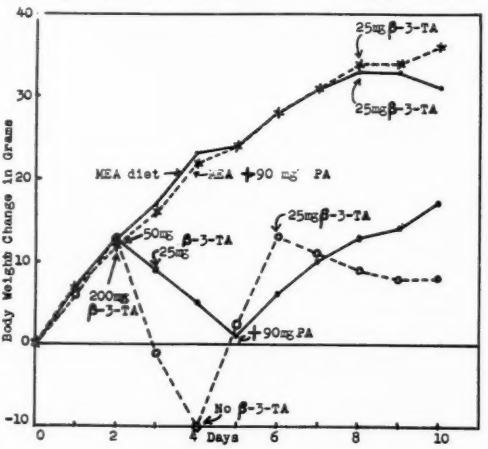

Fig. 1. Curves showing the average changes in body weight of four groups of animals, illustrating the antiphenylalanine properties of β-3-thienylalanine (β-3-TA) in the protein-depleted rat.

three animals in group 3 gained weight equal to the optimum response of the control group 1.

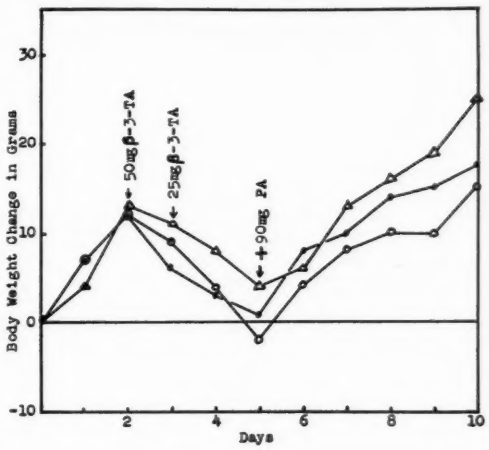

FIG. 2. Curves showing the changes in body weight of each rat in group 3, illustrating the uniform response of each animal.

When 200 mg of β-3-TA was incorporated into the daily diet of each rat in group 4, the loss in weight was very dramatic. The loss was much greater than would result from removal of all phenylalanine. After two days of 200 mg of β-3-TA, the three animals of group 3 were returned to the MEA diet without antagonist. All three rats recovered weight rapidly, indicating that this level of β-3-TA did not produce an irreversible toxic effect. On the sixth day of the experiment the animals of group 4 were again offered a diet containing 25 mg of β-3-TA. The addition of the antagonist at this time again resulted in a loss of weight.

The data plotted in Fig. 1 clearly demonstrate that β-3-thienyl-DL-alanine inhibits the metabolism of phenylalanine during the recovery of the protein-depleted rat.

In Fig. 2 the response of each animal in group 3 is plotted to show that all animals responded quantitatively in a uniform manner. The same consistent data were obtained in each group.

In summary, β-3-thienylalanine inhibited the weight restoration of the protein-depleted rat; this inhibition was completely prevented by additional amounts of phenylalanine.

The results of this experiment indicate the suitability of the protein-depleted rat for the study of amino acid antagonists. Complete results can be obtained in ten days.

References

1. FERGER, M. F. and DU VIGNEAUD, V. *J. biol. Chem.*, 1949, **179**, 61.
2. FRAZIER, L. E. *et al.* *J. Nutrition*, 1947, **33**, 65.
3. PAGE, E., GAUDRY, R., and GINGRAS, R. *J. biol. Chem.*, 1948, **171**, 831.
4. STEFFEE, C. H., JR. *et al.* *Fed. Proc.*, 1949, **8**, 369.
5. WISSLER, R. W. *et al.* *J. Immunol.*, 1946, **52**, 267.

Book Reviews

Fishes of the Western North Atlantic: Lancelets, Cyclostomes, Sharks. (Memoir, Sears Foundation for Marine Research, No. 1.) Henry B. Bigelow, Isabel P. Farfante and W. C. Schroeder. New Haven, Conn.: Sears Foundation, Yale University, 1948. Pp. 576. (Illustrated.) $10.00.

This is the first volume of the *Fishes of the western North Atlantic* and the first attempt in half a century of American ichthyologists to cooperate in preparing a comprehensive descriptive account of fishes. The present work covers the western half of the North Atlantic, including gulfs, seas, and bays, from Hudson Bay southward to the Amazon River. Brackish water species are included, and others close to the borders, when they make for a more adequate understanding of the group. The reports on the three groups of fishes treated may be classed as critical reviews or revisions. Under each species is found a detailed description, including distinctive characters, color, developmental stages, size, habits, abundance, range, relation to man, and occurrence in the Western Atlantic. Each species (with one or two exceptions) is illustrated by an accurate outline drawing. As complete a list of synonyms and references as possible is found under each species.

During the past decade, while this study has been in preparation, I have been in touch with the authors and have observed their careful methods of study, and deliberate and painstaking care in the preparation of this big volume. There are few typographical errors and only minor inconsistencies. This indicates a great amount of work and careful editing. Thus ichthyologists may place much confidence in the work.

The classification and nomenclature is conservative. The authors are to be highly complimented in not accepting or changing scientific names of sharks in general zoological use for a century or more. In preparing keys to the genera and species they have included genera outside the North Atlantic and have based their judgment on a world-wide basis. Many of the keys include all of the known species of that particular genus, with the range given for each species.

The volume is beautifully prepared from the point of view of bookmaking in regard to size and style of type, arrangement, and organization. If future volumes are as well done, the committee in charge may justifiably be very proud.

LEONARD P. SCHULTZ

U. S. National Museum

Landscape as developed by the processes of normal erosion. (2nd ed.) C. A. Cotton. New York: John Wiley, 1949. Pp. 509. (Illustrated.) $10.00.

This is the second edition, revised and much enlarged, of a notable book first published in 1941. Numerous new illustrations have been added, including aerial photographs. It is the initial book of a trilogy; the others are *Climatic accidents in landscape-making* (1942) and *Volcanoes as landscape forms* (1944). The author has kept well in mind the interests of general readers as well as of students who need an authoritative, interesting elementary textbook in the discussed phases of geomorphology. The major topics comprise the mass movement of waste, land forms produced by the erosion and deposition of running water, structural controls, landscape cycles, and features of limestone terrains.

ARTHUR BEVAN

Illinois Geological Survey

Textbook of virology: For students and practitioners of medicine. A. J. Rhodes and C. E. van Rooyen. New York: Thomas Nelson, 1949. Pp. ix + 312. (Illustrated.) $5.00.

The title of this book suggests completeness of coverage of a scientific discipline. In this respect the book is disappointing. In their preface, however, the authors state their aim to be a succinct presentation of the essential features of virus and rickettsial diseases of man for medical students. As such, it has merit.

Brief chapters summarizing the essential physical, chemical and biological properties of viruses introduce the text. Supplemented with generalizations on epidemiology and immunity, standard factual material is presented in a didactic and admittedly dogmatic fashion. Technical procedures, such as those of centrifugation, electron microscopy, and egg and tissue cultivation are outlined; rather concise staining directions are included. Good reproductions of diagrams and electron micrographs serve as visual aids to the exposition.

The various disease states of man are presented in an inclusive fashion with emphasis on clinical features; the pathologic manifestations, diagnostic aids, prophylactic and therapeutic procedures provide balance. The essential characteristics of the etiologic agents are outlined briefly and specific epidemiologic problems are presented. Throughout, the text assumes the reader's familiarity with the vocabulary of medicine and there is little exposition beyond the special subject. Terseness is a conspicuous feature.

The authors' own prefatory statements justify the suggestion that this brief text represents a condensation of certain features of their larger work on the same subject; the absence of any bibliography in the present book limits its usefulness. As an introduction to human virus and rickettsial diseases, leveled at the specified group, the book may serve a useful purpose in spite of its limitations.

WILLIAM S. PRESTON

University of Michigan

Modern science and its philosophy. Philipp Frank. Cambridge, Mass.: Harvard Univ. Press, 1949. Pp. 324. $4.50.

In 1941, Philipp Frank collected ten interesting papers from his own pen, written between 1908 and 1938, and republished them under the title *Between physics and philosophy*. The present work is a republication of these with an addition of other articles, all previously published, of more recent date. Added to this collection is an historical preface, full of personal reminiscences, and tracing the history of the movement of logical empiricism which the author fervently espouses. Although the book as such lacks continuity between its chapters, the growth of the philosopher's own views, which is apparent throughout, provides a bond of unity that welds the work into an attractive whole.

The book's attention can hardly be said to be focused upon the crucial issues of recent science; the work is clearly therapeutic, and the treatment exhibits a consuming desire to show that physics furnishes no nourishment to the advocates of metaphysical systems. The book is thus meant to clear the air for a proper view of perennial philosophic problems without pretending to solve them and, like all of Frank's writings, it is successful in achieving that end.

HENRY MARGENAU

Yale University

Pedigrees of negro families. R. Ruggles Gates. Philadelphia-Toronto: Blakiston, 1949. Pp. vii + 267. (Illustrated.) $5.50.

Inspection of pedigrees has been a predominant method of analysis throughout the short history of human genetics. Because of the expense of population surveys in which all known characters are recorded, the pedigree method of tracing a particular attribute along one or more family lines will probably provide most of our information on inheritance in man for a long time hence. Prof. Gates, in *Pedigrees of negro families*, adds to the record of sample cases for the three major divisions of mankind, the literature in European languages and such collections as the *Treasury of human inheritance* being chiefly concerned with Caucasoids and the two volumes by Komai on Japanese material representing the Mongoloids.

Two hundred eighteen pedigrees on 72 different characters are discussed, of which 35 show the presence of more than one character. The pedigrees were collected by students (of what and where is not specified) usually on some condition in their own families or in a family with which they were intimate. The material is mainly from the United States, but Canada, the West Indies, and British Guiana are represented.

A feature of special interest is the suggestion that skin color in man is determined by three pairs of additive genes. A chart illustrating eight skin color phenotypes is the frontispiece. The proposed correspondence of these phenotypes with the possible genotypes (see especially p. 254) on the three-factor hypothesis is not made explicit, and statistical tests of the hypothesis are not given.

Two considerations should be kept in mind by those who use this work:

(1) Pedigree information collected by students for course credit is sometimes faked (usually with reference to published sources). The author has seemingly made such checks as were possible regarding this source of error (cf. p. 1).

(2) The data as presented are not sufficient in themselves to establish the degree or the mode of inheritance for any of the mentioned characters. The history of genetic knowledge of the ABO blood groups is here an object lesson on the limitations of pedigree inspection. In spite of a relative abundance of pedigree data for a character set which shows full penetrance and constant expressivity, an incorrect (meaning much less probable) mode of inheritance of the ABO system was accepted for more than twenty years. In human genetics, degree and mode of inheritance can be considered well established only when results are concordant for all of three types of tests: (a) pedigree analysis, (b) gene frequency statistical tests, and (c) twin studies.

These strictures are not passed in criticism of Prof. Gates. He has done an admirable job with the available information. But his information should be considered a start, and not a finish. Some of the data is of sufficient bulk to permit statistical analysis; for example, more than fifty cases each are recorded for color blindness, baldness, polydactyly, allergy, and musical ability.

J. N. SPUHLER

Ohio State University

Trees: Yearbook of agriculture, 1949. (U. S. Dept. of Agriculture.) Alfred Stefferud. (Ed.) Washington (25), D. C.: Supt. of Documents, 1949. Pp. xiv + 944. (Illustrated.) $2.00.

The 1949 yearbook of agriculture, *Trees*, is the tenth of a series of reference volumes prepared by the Department of Agriculture since 1936, when the annual progress report and statistical summary content was discontinued. This is the third of the series to be edited by Alfred Stefferud. Like the others, it represents the cooperative effort of a great many individuals, most of whom are or have been members of the Department of Agriculture, with the majority from the U. S. Forest Service.

The contents consist of 138 separate short treatises grouped together under four broad headings, namely: "The Tree," "Trees and Homes," "Forests and Men," and "Lists and Other Aids."

"The Tree" includes an exceptionally concise discussion of tree growth and development, considerable miscellaneous information about noteworthy and historical trees, and a question and answer section that the reviewer believes rightfully belongs under "Lists and Other Aids."

"Trees and Homes" considers trees from the arboricultural viewpoint. It includes descriptive lists of shade and ornamental trees for town and country and various geographical regions, as well as pointers on the establishment and care of these trees.

"Forests and Men" comprises about two-thirds of the yearbook and deals rather broadly with the entire gamut of forestry activities in the United States. It is subdivided into several sections that cover the following aspects of forestry: ecology; seeding and planting; genetics; management and care of private and public forests; protection from insects, diseases, parasites, and fire; wildlife; water relations; wood utilization; history; economics and policy.

"Lists and Other Aids" is essentially an appendix to the main text of the book. It presents information on tree and wood identification, including useful diagnostic keys and helpful illustrations, lists of trees for special purposes, a vacation guide locating and in part describing forest areas administered by the federal government and the states, a reference bibliography, and a woodsman's glossary.

In addition to the black and white text illustrations, there is a 16-page section of colored plates "chosen to summarize the main points in this book and to awaken interest in the purposes and pleasures of trees and forests."

Prepared by well-qualified authorities and carefully and objectively written, the book succeeds in its purpose of relating to the general public in considerable detail a very important phase of the work of the Department of Agriculture. At the same time, the volume will take its place as a readable, reliable, and unusually complete compendium of tree and forestry facts for teachers and others who would like society to make more effective use of this renewable organic resource. Throughout its pages there is a strong undertone of sound conservation of natural resources, a guide to action that we must adopt if we are to give future generations a chance to attain a reasonably adequate standard of living. The book is highly recommended.

ROBERT A. COCKRELL

University of California, Berkeley

NEWS and Notes

W. Albert Noyes, Jr., chairman of the Department of Chemistry, University of Rochester, became editor of the *Journal of the American Chemical Society* on January 1. He succeeds **Arthur B. Lamb,** of Harvard University, who retired from the post after 31 years' service.

John W. Vanderwilt has been named president of the Colorado School of Mines to succeed **Ben H. Parker,** who has submitted his resignation to take effect April 1, when he will return to the Frontier Refining Company of which he was formerly vice president. Dr. Vanderwilt has been doing consulting geologic work in Denver and spent three months in Norway last summer as geological consultant under the Marshall Plan.

Gordon H. Scott was named dean of the Wayne University College of Medicine on January 10. He was recommended for the appointment by **David D. Henry,** university president, who has been acting dean since September 1, 1948, when **Hardy A. Kemp** resigned. Dr. Scott came to Wayne three years ago from the University of Southern California where he was head of the Department of Anatomy.

W. A. Selle, formerly professor of physiology and medical physics at the University of Texas Medical School, is now professor of biophysics at the University of California Medical School at Los Angeles.

Charles S. Piggot, Tennessee chemist who participated in the Bikini atom bomb tests, has been appointed scientific attaché at the U. S. Embassy in London. His task will be to improve cooperation among the American and British governments and scientists.

R. W. Pennack, of the Department of Biology, University of Colorado, has been invited to participate in the symposium "Ecologie des Groupements Animaux et Mixtes," to be held in Paris, February 20–25.

Harry V. McNeill has joined the staff of the National Institute of Mental Health, U. S. Public Health Service. He will serve as regional mental health consultant in clinical psychology in the New York City and Boston regional offices. Dr. McNeill was formerly area clinical psychologist, New York State Veterans Administration.

Pasquale Lino Trombetta, assistant professor in the Department of Comparative Anatomy and Zoology of the University of Milan, has been appointed assistant professor of biology at Quincy College, Quincy, Illinois. Dr. Trombetta will begin teaching in February and plans to continue his investigations in embryology.

Harry S. Ladd, of the U. S. Geological Survey, has been granted a request for relief from his duties as assistant chief geologist to resume research work in the paleontology and ecology of mollusks for the Geological Division. **Esper S. Larsen 3d,** who has been with the Geological Survey since November, 1942, will succeed Dr. Ladd. Since the war Dr. Larsen has been engaged in petrologic researches.

Visitors to U. S.

L. E. Howlett, associate director, Division of Physics, and **R. H. Field,** chief, Metrology Section, Division of Physics, both of the National Research Council of Canada, recently visited the National Bureau of Standards.

C. J. Mackenzie, president of the National Research Council of Canada and of the Canadian Atomic Energy Control Board, visited the Argonne National Laboratory on January 17, and the University of California Radiation Laboratory in Berkeley on January 23. Dr. Mackenzie was accompanied by **C. A. Nelson,** USAEC Liaison Officer at the Canadian Atomic Energy Project, Chalk River, Ontario.

Grants and Awards

The Sherman Fairchild Award for outstanding achievement in the field of aerial photography was presented to John V. Sharp, 36-year-old Bausch and Lomb Optical Company scientist, on January 12 during the meeting of the American Society of Photogrammetry in Washington, D. C. Dr. Sharp received the award for his development of the Autofocus Rectifier, an automatic instrument that enlarges, prints, and automatically reduces aerial photographs to a common scale and level.

Richard D. Brauer, professor of mathematics, University of Michigan, has been awarded the **Cole Prize for Algebra** by the American Mathematical Society. The prize was given to Prof. Brauer for a series of papers he did on group characters of groups of finite order. The award is made every five years for the most outstanding contribution in algebra made during that period.

The Leidy Medal, awarded every three years in honor of Joseph Leidy, Philadelphia scientist, has been given this year to Warren Poppino Spencer, geneticist of Wooster College, Wooster, Ohio. Dr. Spencer was chosen for his studies of wild populations of the fruit fly and other contributions to genetics and zoology.

Fellowships and Prizes

The Royal Anthropological Institute will award in 1950, and every year thereafter, the **Curl Bequest Prize** for the best essay on the results or analysis of anthropological work carried out or published during the preceding ten-year period, or for the history of some useful line in anthropology during the same period. Essays, not exceeding 25,000 words, or less than 10,000 should be submitted by *April 30* to the Honorable Secretary, Royal Anthropological Institute, 21 Bedford Square, London, W.C. 1, to whom inquiries should also be addressed. The winning essays are to be published in the *Journal of the Royal Anthropological Institute.* A prize of £50 will be awarded this year to the winner, or winners if two or more essays are considered of equal merit.

A fellowship in nutrition has been established at the Philadelphia General Hospital by Swift and Company for the study of protein metabolism in relation to antibody response. The fellowship is for a one-year period and is being offered in conjunction with the hospital's nutrition project and nutrition clinic, under the direction of Michael G. Wohl.

A research training program in enzyme chemistry, with particular reference to heart muscle, has been inaugurated by the National Heart Institute, U. S. Public Health Service, at the Institute for Enzyme Research, University of Wisconsin. The 12-month program, which is under the direction of David E. Green, professor of enzyme chemistry, will include full-time research in some phase of enzyme chemistry and a regular series of lectures by members of both the institute's staff and other departments of the university, and guest lecturers from other universities. The number of trainees will be limited to ten and may include senior investigators. Candidates must have a Ph.D. or M.D. degree in order to qualify. Stipends conform to those in effect for postdoctorate research fellows of the Public Health Service. Applications, obtainable from the Institute for Enzyme Research, Madison, Wisconsin, should be submitted in duplicate to Dr. Green. A trainee can start the program anytime during the period July 1950 to July 1951.

Colleges and Universities

The University of Illinois at Urbana has appointed two new members to its Zoology Department staff, which is now a separate department of the university. The new staff members are M. S. Rose, formerly of Smith College, associate professor, and H. I. Fisher, formerly of the University of Hawaii, assistant professor in charge of general zoology. F. B. Adamstone is now head of the department.

The University of Delaware has announced the organization of the Haskell Research Foundation, a nonprofit group supporting research in all fields of science. The foundation is an outgrowth of the former Harry G. Haskell Sr. Research Association, originated in 1942 for the study of animal diseases.

A new Department of Biological Sciences replaces the former Departments of Botany and Zoology at **Northwestern University.** Frank A. Brown, Jr. is chairman of the new department. Recent additions to the staff include George H. Mickey, associate professor of biology, formerly of Louisiana State University, and Ray L. Watterson, associate professor of biology, formerly of the University of Chicago. A new building, the Mark W. Cresap Laboratory of Biological Sciences houses the department's laboratories, offices, and classrooms.

The Department of Zoology of the University of Washington has added three new members to its staff: Kenneth L. Osterud, from the University of Minnesota, is developing a program of teaching and research in protozoology; Richard C. Snyder, from the University of Arizona, will head a program in vertebrate anatomy; and Marko Zalokar, from the California Institute of Technology, is contributing to the program in experimental embryology. Albert Tyler, associate professor of biology at California Institute of Technology, has been appointed Walker-Ames Professor in Zoology for the winter quarter.

Yale University, in cooperation with the Conservation Foundation, has established a graduate program of research and instruction in conservation of natural resources. Paul B. Sears, in the newly created post of professor of conservation, will be in charge of the program, to begin in September. Dr. Sears is now at Oberlin College, but will join the Yale faculty next summer. The course, which is for graduate students only, will require two years of study and research leading to the degree of master of science in conservation. The program will be administered by the Division of Sciences and the Graduate School. Edmund W. Sinnott, director of the division, in announcing the new program said, "The time has come when the whole field of conservation is so important that the training of competent personnel is a problem for our universities."

The Science Division of Colorado State College of Education is sponsoring an exhibition in April of visual aids for use in secondary schools in the teaching of science and mathematics. Suggestions for sources of material are solicited by the chairman, Charles W. Foster, Hadden Hall, Colorado State College of Education, Greeley.

Meetings and Elections

The First International Congress on Diseases of the Chest will be held at the Carlo Forlanini Institute in Rome, September 17–20, under the auspices of the Council on International Affairs of the American College of Chest Physicians and the Carlo Forlanini Institute, and in collaboration with the National Institute of Health and the Italian Federation Against Tuberculosis. Physicians interested in attending should write Dr. Chevalier L. Jackson, Chairman of the Council on International Affairs, American College of Chest Physicians, 500 North Dearborn Street, Chicago 10, Illinois, or Professor A. Omodei Zorini, Carlo Forlanini Institute, Rome, Italy.

The International Committee of the International Congress of Genetics has accepted an invitation issued by Italian geneticists for the **Ninth International Congress of Genetics** to meet in Italy during the summer of 1953. The dates and place of the meeting will be announced later.

The Society of American Bacteriologists has elected the following officers for 1950: president, Barnett Cohen, Johns Hopkins Medical School; vice president, Walter J. Nungester, University of Michigan; secretary-treasurer, John E. Blair, Hospital for Joint Diseases, New York City. Honorary membership in the society has been conferred upon

Albert Jan Kluyver, Technische Hoogeschool, Delft, The Netherlands.

The Ecological Society of America has elected the following officers for 1950: president, E. Lucy Braun, professor emeritus, University of Cincinnati; vice president, R. V. Truitt, Department of Research and Education, Solomons, Maryland; secretary, William A. Castle, Mary Washington College of the University of Virginia; treasurer, William T. Penfound, University of Oklahoma.

Officers elected by the **American Society of Human Genetics** for 1950 are: president, L. H. Snyder, University of Oklahoma; vice president, Curt Stern, University of California; and secretary-treasurer, Herluf H. Strandskov, University of Chicago.

The Mycological Society of America elected the following officers at its 16th annual meeting: president, A. H. Smith, University of Michigan; vice president, Kenneth B. Raper, Northern Regional Research Laboratory; councillors, F. K. Sparrow, University of Michigan and G. W. Fisher, Washington State College.

A symposium on genetic psychology will be held Thursday evening, April 20, at Clark University, Worcester, Massachusetts. Heinz Werner, professor of Genetical Psychology at Clark, will be chairman of the symposium. Speakers will be Anna Freud, psychologist and daughter of the late Sigmund Freud, Robert R. Sears, professor of education and child psychology and director of the Laboratory of Human Development, Harvard University, and Lawrence K. Frank, director of the Caroline Zachry Institute of Human Development, New York. The symposium will precede a meeting of the Eastern Psychological Association, which will be held at Clark on April 21–22.

Officers elected for 1950 by the **Western Society of Naturalists** at its annual winter meeting are as follows: president, Lawrence R. Blinks, Hopkins Marine Station, Stanford University, Pacific Grove, California; vice president, Curt Stern, Department of Zoology, University of California at Berkeley; secretary-treasurer, William M. Hiesey, Carnegie Institution of Washington, Stanford, California. Members-at-large on the Executive Committee are Carl L. Hubbs, Scripps Institution of Oceanography, University of California; and Dixy Lee Ray, University of Washington, Seattle.

NRC News

The Prevention of Deterioration Center has appointed Robert M. Burns, director of chemical research of the Bell Telephone Laboratories, as chairman of its Advisory Committee. Dr. Burns succeeds John C. Warner, who will become president of Carnegie Institute of Technology in July. The center operates in the Division of Chemistry and Chemical Technology, and provides extensive information, publication, research advisory, and research coordinating services, particularly to the Army, Navy, and Air Force.

Two parts of a book to be called *Introduction to the prevention of deterioration of materials* have recently been published by the center. The tentative outline of the completed book calls for four sections: Some Important Factors in Deterioration; Materials and Their Preservation; Assembled Units and Their Preservation; and Some Special Aspects of Preservation. The parts which have been published in booklet form deal with the preservation of electrical and electronic equipment; and climate and deterioration. Copies of these booklets can be borrowed from the council for inspection and comment.

Eight new directors of the **American Geological Institute** have been appointed by constituent societies to serve for 1950–51. They are: Henry C. Cortes, Magnolia Petroleum company, Dallas, for the Society of Exploration Geophysicists; F. M. Fryxell, dean of science at Augustana College, for the Geological Society of America; M. M. Leighton, chief of the Illinois Geological Survey, for the Society of Economic Geologists; J. P. Marble, research geochemist of Washington, D. C., for the Mineralogical Society of America; Norman D. Newell, professor of paleontology at Columbia University, for the Paleontological Society; Frank Neumann, U. S. Coast and Geodetic Survey, for the Seismological Society; R. Dana Russell, Navy Electronics Laboratory, San Diego, for the Society of Economic Paleontologists and Mineralogists; and John A. Wilson, assistant professor of geology, University of Texas, for the Society of Vertebrate Paleontology. Each of the 11 member societies of the institute appoints two members to the board of directors, to serve alternating two-year terms. In addition the NRC appoints one director; the chairman of the council and the chairman of the Division of Geology and Geography are *ex officio* directors of the institute.

The Chemical-Biological Coordination Center of the National Research Council announces the availability of *Summary Tables of Biological Tests*, Vol. 1, No. 1 and 2. These tables contain the results of tests performed on compounds submitted to the center for preliminary screening to determine their biological effects on a series of laboratory animals and plants. The tables are arranged according to the type of test employed, followed by a description of the test technique involved. Within the type of test the chemicals are listed alphabetically by the Chemical Abstracts System of Nomenclature and include the structural formula and a brief statement of test results. Reports on antibacterial, arachnidicide, fungicide, insecticide, plant growth regulator, insect and rat repellency, rodenticide, mammalian toxicity, antimalarial, brucellosis, cancer, snail control, and rickettsia are included in these issues. Requests for these tables should be addressed to the National Research Council, Chemical-Biological Coordination Center, Washington 25, D. C.

Publication problems of primary scientific journals will be the subject of a two-day conference to be

held February 10 and 11 under the sponsorship of the NRC. The conference has been scheduled in response to the many requests from scientific investigators and from persons interested in the dissemination of research results.

The first day of the conference will be devoted to problems of publication of scientific research. Journals of primary publication are faced with serious difficulties which limit their effectiveness in their function of dissemination. Other media of original publication, such as private and government reports, have not proved to be effective substitutes.

February 11 will be devoted to proposals for the solution of problems raised and to exploration of possible aids. This conference will include representatives from government agencies, institutions, publishers, and those industries involved in primary scientific publication. Its topic will be "Cooperative Efforts in the Publication of Original Scientific Research." Any interested organization is invited to send a representative. The names of such delegates should be forwarded to the National Research Council, 2101 Constitution Avenue, Northwest, Washington, D. C., before *February 1* so that pertinent documents may be sent to them in advance.

The latest report of the **Committee on Geological Personnel of the Division of Geology and Geography** is now available without charge from the division office. The report summarizes data for 1948–1949 on the enrollment and training of undergraduate and graduate students in geology, the supply and demand situations for trained geologists, and the growth of professional geological societies.

The parts of the report dealing with the growth of training in geology and the supply of geologists are based on data collected from 75 educational institutions by A. I. Levorsen, professor of geology and dean of the School of Mineral Sciences at Stanford University, and a member of the committee. These data showed that the 1949 enrollment in geology exceeded that of any previous year, being 40% higher than for 1947–48, and more than twice as great as for the highest prewar year; there were more than four thousand undergraduates enrolled in geology, and about 1,350 graduate students. (A survey by the U. S. Office of Education has shown that, during the year ending June 30, 1949, 1,851 bachelor's, 385 master's, and 88 doctor's degrees were granted in geology. The committee estimates that 60% of these geologists entered the petroleum industry.) It is estimated that the output of trained geologists in June, 1950, may exceed 2,000. The best estimates which can be made on the demand for geologists, however, indicate that only 1,200 men with bachelor's degrees can be used; the war-created deficit of geologists has thus been overcome, except in a few specialized fields at the doctorate level. The number of geologists affiliated with scientific and professional societies has shown a correspondingly large increase in recent years, with an over-all gain of 260% in the past decade.

The work of the Committee on Geological Personnel is being assumed by the NRC's American Geological Institute, which will undertake annual supply and demand studies beginning this year.

Deaths

Durwald Frederick Fisher, pathologist at the Bureau of Plant Industry, Soils, and Agricultural Engineering of the U. S. Department of Agriculture, died of a heart attack on September 18 at the age of 61. While in charge of the U. S. Fruit Disease Field Laboratory in Wenatchee, Washington, Mr. Fisher was successful in research on the removal of arsenic spray residue from apples and the prevention of apple storage scald. As head of research on the transportation and storage of fruits and vegetables, he conducted valuable investigations in the problems of the maintenance of quality and prevention of spoilage.

Max Berek, director of the Department of Science of the Leitz Works in Germany, died on October 15 in Frieburg. Dr. Berek, who was 63 at the time of his death, contributed extensively to the development of the Leica camera lenses. He is the author of the standard text, *Fundamentals of practical optics.*

George Samuel Rice, 84, retired chief mining engineer of the U. S. Bureau of Mines, died in Takoma Park, Maryland, on January 3. Dr. Rice participated in the ventilation tests and studies which were conducted in connection with the construction of the Holland Tunnel between New York and New Jersey. At the Bureau of Mines, he did research in the prevention of coal mine explosions and the efficacy of rock-dusting in rendering coal dust non-explosive.

A team of astronomers from Harvard College Observatory will leave for South Africa next month to begin an 18-month study of the 30,000 light years of space between the earth and the center of the Milky Way. The expedition will gather information on the central star clouds of the southern constellations of Sagittarius and Scorpio and investigate the origin of stars in the interstellar dust and gases in the center of the Milky Way.

The project is under the direction of Harlow Shapley, director of the observatory. Bart J. Bok, associate director, is in charge of the expedition. His wife, Priscilla F. Bok, also an astronomer, will accompany him. Other members of the team are Ivan R. King and Ueo van Wyck. Astronomers from observatories in Northern Ireland and Eire will share the observing time with the Harvard scientists, but will be working on different projects.

Headquarters for the expedition will be located at the Boyden Station of the Harvard Observatory in Bloemfontein, in the Orange Free State of South Africa, which is the southernmost of Harvard's five observing stations. This station is located at a latitude of 30°, and the center of the Milky Way passes directly over it every night.

A large Baker-Schmidt type of telescope and the world's largest objective prism will be used to photograph the 30,000 light years of space. Previous explorations of the Milky Way have been limited to distances of less than 10,000 light years.

The Mayo Foundation's exhibit "Tumors of the Lung" and "Cancer Cells in Sputum and Bronchial Secretions," on loan to the Armed Forces Institute of Pathology, is now on exhibition in the Army Medical Museum in Washington, D. C. The exhibit won a prize at the American Medical Association's June meetings in Atlantic City as an outstanding example of the use of a combination of colored wax reproductions and colored photographs of gross specimens and associated x rays to illustrate a medical topic. The exhibit was prepared under the technical supervision of Arthur H. Bulbulian, director of the Museum of Medicine and Hygiene, Mayo Foundation.

The Numerical Index to the Bibliography of Scientific and Industrial Reports, Volumes 1–10, 1946–1948, a new guide to the government's collection of wartime and postwar technical research reports, is available from the Special Libraries Association. The 530-page, planograph report is a joint publication of the Science-Technology Group of the Special Libraries Association, the Socony-Vacuum Laboratories of Paulsboro, New Jersey, and the Offices of Technical Services, U. S. Department of Commerce.

Publication reports of the OTS which have appeared in the first ten volumes of the *Bibliography* are listed by number and alongside each number the volume and page numbers of the *Bibliography* are given so that additional details, including the abstract of the report, can be obtained. Formerly this information could be secured only from the OTS catalogue. Research and development fields covered by monthly issues of the *Bibliography* include aeronautical engineering, chemicals and allied products, drugs and pharmaceuticals, metallurgy, meteorology, minerals, nuclear physics, psychology and aptitude testing.

Orders for the *Index* should be placed with the Special Libraries Association, 31 East 10 Street, New York City 3. The price is $10.

The National Heart Institute has established a chemical pharmacology section as part of its research program. Bernard B. Brodie, associate professor of biochemistry at New York University College of Medicine will direct the section. Sidney Undenfriend, assistant professor of biochemistry at Washington University School of Medicine, St. Louis, will head the units within the section and conduct research in the metabolic transformation in the body of drugs and other substances of biological significance to the cardiovascular system, the kidney, and the aging process. Julius Axelrod, research chemist at New York University Medical School, will be in charge of biochemical research. The scientists will work under the direction of James A. Shannon, the institute's associate director for research.

The Philadelphia section of the American Chemical Society will sponsor special noncredit evening courses in chemical engineering, thermodynamics, and instrumental electronics this spring. The course in chemical engineering thermodynamics will be presented by eight specialists in the field. There will be two-hour lectures on eleven successive Monday evenings, beginning February 13. The course in instrumental electronics is designed to meet the needs of chemists who use electronic apparatus in the laboratory, and will consist of ten lectures on successive Tuesday evenings beginning February 14. Lecturers will be E. N. Shawhan, Physical Laboratory, Sun Oil Company, and E. J. Serfass, of Lehigh University.

The lectures will be held at the Philadelphia College of Pharmacy and Science in Philadelphia. Further information may be had from E. J. Rosenbaum, Sun Oil Company, Norwood, Pennsylvania, who is chairman of the Chemical Education Committee of the Philadelphia Section. Attendance is not limited to members of the society.

Brookhaven National Laboratory has opened two new research laboratories in the Medical Department, one for the Division of Bacteriology and Virology and the other for the Division of Pathology. William M. Hale is head of the Division of Bacteriology and Virology and is bacteriologist-in-chief of the laboratory hospital. He was formerly professor of bacteriology and head of the department at the University of Iowa College of Medicine. S. C. Madden is head of the Division of Pathology and pathologist-in-chief of the Brookhaven Hospital. He was formerly professor of pathology and chairman of the department, Emory University School of Medicine. Other appointments in these two divisions are Ruth M. Drew, assistant bacteriologist; John H. Prodell, Jr., junior bacteriologist; and James A. Francher, Jr., junior pathologist.

A chemical pharmacology section has been established as part of the National Heart Institute of the National Institutes of Health in Bethesda, Maryland. Bernard B. Brodie, associate professor of biochemistry at the New York University College of Medicine, has been appointed to direct the section. Sidney Udenfriend, assistant professor of biochemistry at the Washington University School of Medicine, will head the units within the section, and Julius Axelrod, research chemist at the New York University Medical School, will conduct biochemical research.

The Maury, a 62-foot boat built by the Chesapeake Bay Institute of The Johns Hopkins University, was launched in Baltimore on January 20. The boat, specially designed and outfitted with two laboratories, will be used to study the waters and marine life of the Chesapeake Bay from the mouth of the Susquehanna River to the lower Capes of Virginia. The project, begun over a year ago, is the first large scale scientific study of this major estuary and is supported by the states of Maryland and Virginia and the U. S. Navy. This research vessel was named for Matthew Fontaine Maury, early Virginia oceanographer.

Personnel Placement

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1. Rate: 15¢ per word, minimum charge $3.00 for each insertion. If desired, a "Box Number" will be supplied, so that replies can be directed to SCIENCE for immediate forwarding. Such service counts as 8 words (e.g., a 25-word ad, plus a "Box Number", equals 33 words). All ads will be set in regular, uniform style, without display; the first word, only, in bold face type.

For *display* ads, using type larger or of a different style than the uniform settings, enclosed with separate border rules, the rate is $16.00 per inch; no extra charge for "Box Numbers".

2. Advance Payment: All Personnel Placement ads, *classified* or *display*, must be accompanied by correct remittance, made payable to SCIENCE. Insertion can not be made until payment is received.

3. Closing Date: Advertisements must be received by SCIENCE, 1515 Mass. Ave., N.W., Washington 5, D. C., together with advance remittance, positively not later than 14 days preceding date of publication (Friday of every week).

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Microbiologist: Ph.D., 12 years research experience, especially with anaerobic microorganisms, desires teaching or research position. Box 11, SCIENCE. X

Pharmaceutical Chemist: Ph.D.; several years, teaching experience (chemistry), eastern university graduate school; seven years, head division biochemistry food industry; five years, director, research and development, biological laboratories; in late thirties; for further information, please write Burneice Larson, Medical Bureau, Palmolive Building, Chicago. X

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MARINE BIOLOGIST

Position as resident investigator at the Duke University Marine Laboratory. Opportunities for research in various phases of marine biology for advanced graduate or post-doctorate young man. Salary dependent on qualifications. House provided. Send application to Dr. C. G. Bookhout, Department of Zoology, Duke University, Durham, N. C. X

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Personnel Placement

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PHARMACEUTICAL-NUTRITIONAL CHEMIST

Nationally known manufacturer of vitamin food supplements has opening for pharmaceutical-nutritional chemist experienced in development of new pharmaceutical and nutritional products. Ph.D. preferred; however, will consider M.S. with qualified experience. California location. Excellent salary. Box 13, SCIENCE. X

Positions Open:
(a) **Pharmaceutical chemist** or chemist qualified in nutrition to direct research and product development; industrial company specializing in vitamin and mineral food products; Ph.D. preferred; will consider candidate with Master's provided thoroughly experienced; West. (b) **Instructor, radiographic technique;** science major, teaching and research experience required; department, radiology, university medical school; $4800. (c) **Two instructors in anatomy;** university school of medicine; Ph.D.'s or physicians interested in career in anatomy; will consider young physicians interested in year's training in anatomy before entering residency training, particularly surgery. (d) **Virologist;** preferably Ph.D.; research project involving virology, large teaching hospital; laboratory staff of more than forty; university medical center; Middle West. S1-4 Burneice Larson, Medical Bureau, Palmolive Building, Chicago. X

The Market Place

CHARGES and REQUIREMENTS for "MARKET PLACE" Ads

1. Rate: 20¢ per word for *classified* ads, minimum charge $5.00 for each insertion. Such ads are set in uniform style, without display; the first word, only, in bold face type.
For *display* ads, using type larger or of a different style than the uniform classified settings, and entirely enclosed with separate rules, rates are as follows:

Single insertion	$16.00 per inch
7 times in 1 year	14.50 per inch
13 times in 1 year	13.00 per inch
26 times in 1 year	11.50 per inch
52 times in 1 year	10.00 per inch

2. Payment: For all *classified* ads, payment in advance is required, before insertion can be made. Such advance remittances should be made payable to SCIENCE, and forwarded with advertising "copy" instructions.
For *display* advertisers, monthly invoices will be sent on a charge account basis—providing satisfactory credit is established.

3. Closing Date: Classified advertisements must be received by SCIENCE, 1515 Massachusetts Avenue, N.W., Washington 5, D. C., together with advance remittance, positively not later than 14 days preceding date of publication (Friday of every week).

For proof service on display ads complete "copy" instructions must reach the publication offices of SCIENCE, 1515 Massachusetts Avenue, N.W., Washington 5, D. C., not later than 4 weeks preceding date of publication.

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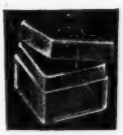

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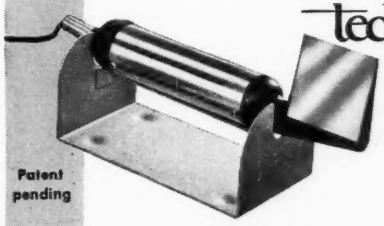

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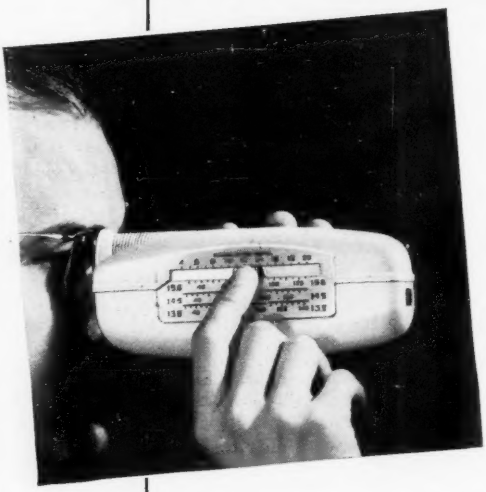

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